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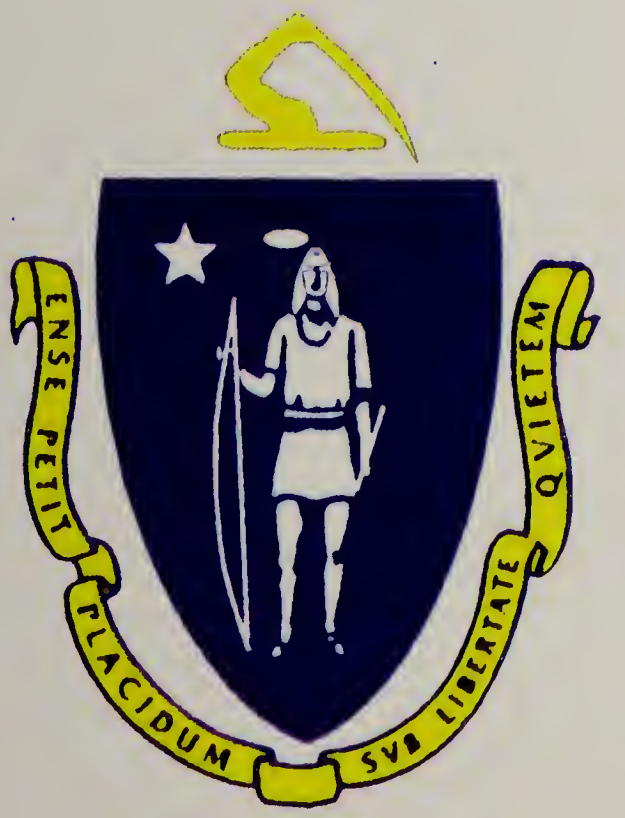

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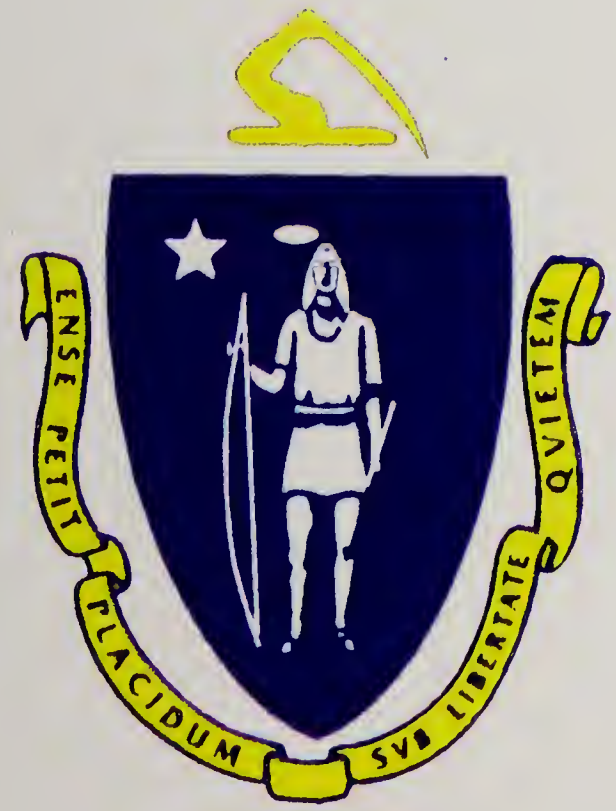

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RESPONSE TO SUPERTERRORISM

Supplemental Course Material for Nuclear, Chemical and Biological Terrorism

Prepared by:

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August 1996

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RESPONSE TO SUPERTERRORISM

Course Material

Unit 1: The Threat of Terrorism **Page 1-1**

Terrorism: How Vulnerable is the United States? Stephen Sloan, *Terrorism: National Security Policy and the Home Front*, The Strategic Studies of the U.S. Army War College, May 1995. (Page 1-1).

Terrorism: Motivations and Causes. Paul Wilkinson, Canadian Security Intelligence Service, January, 1995. (Page 1-13).

The Threat of Chemical/Bilogical Terrorism. Ron Purver, Canadian Security Intelligency Service, August, 1995. (Page 1-21)

The Continuing Threat from Weapons of Mass Destruction. Dr. Gordon C. Oehler, Director, Nonproliferation Center. Testimony before the Senate Armed Services Committee, March 27, 1995. (Page 1-33).

Terrorism Backgrounder. Federal Emergency Management Agency. (Page 1-59).

Unit 2: Chemical Warfare Agents **Page 2-1**

Introduction	2-1
Chemical Agents	2-3
Civilian Chemical Accidents	2-23
Potential Chemical Weapons	2-26
Protection Against Chemical Weapons	2-27
Decontamination	2-30
Dispersal of Chemical Warfare Agents	2-40
Material Safety Data Sheets	
Sarin	2-43
Soman	2-51
Lewisite	2-60
VX	2-69
Mustard	2-78

Unit 3: Biological Weapons **Page 3-1**

The Biological Weapon: A Poor Nation's Weapons of Mass Destruction
Lt. Col. Terry Mayer, USAF. (Page 3-1)

Twenty First Century Germ Warfare. Lt. Col. Robert Kadlec, USAF. (Page 3-17)

Biological Warfare Defense Information Sheets
Anthrax 3-33
Botulism 3-35
Plague 3-37
Q Fever 3-39
Ricin 3-41
SEB 3-43
Tularemia 3-45

Unit 4: Nuclear Terrorism **Page 4-1**

The Nuclear Threat. Dick Ward, Criminal Justice International. (Page 4-1)

Smuggling Special Nuclear Material. A. Robitaille and R. Purver. May, 1995.Canadian Security Intelligence Service. (Page 4-5)

Unit 5: Miscellaneous Material **Page 5-1**

Bomb Attacks in City Centers. Timothy Hillier. Chief Superintendent, London Police. September 1994. (Page 5-1)

Local Terrorism Planning Model. (Page 5-7)

TERRORISM: HOW VULNERABLE IS THE UNITED STATES?

Stephen Sloan. From Terrorism: National Security Policy and the Home Front
Edited by Stephen Pelletiere, published by
The Strategic Studies Institute of the U.S. Army War College, May 1995.

INTRODUCTION

If there is a "fog of war," there is probably a more dense "smog of terrorism," for the small nature of terrorist groups, their close interpersonal communications, and their predilection for soft targets of opportunity make it difficult to predict their future operations. Counterterrorism analysts must therefore peer through a very cloudy crystal ball when assessing the intentions, capabilities, and targets of existing and future terrorist groups. Life would be easier if, as when assessing a conventional army, analysts could pour over communications intercepts to discern orders of battle and make predictions based on the enemy's known doctrine and strategy. The problem of penetrating the "smog of terrorism" is further exacerbated by the fact that it is difficult to infiltrate terrorist cells to acquire the tactical information needed to prevent, or at least to mitigate, a potential threat or actual incident. The most sophisticated capabilities in the arsenal of technical intelligence are no substitutes for the HUMINT (human intelligence) capabilities that are needed to gather information on terrorists. The problem of predictive analysis is further complicated by the fact that even if terrorist organizations have an encompassing ideology—or what is at best a proto-strategy—it tends to be rather general in nature and directed at establishing a broad declaration on revolutionary action that may not provide a clear plan for action that can enable the analyst to have a foundation for assessing future terrorist operations. Furthermore, predictive capabilities are challenged by the tact that there is a whole range of potential new terrorist weapons and associated scenarios for destruction that create major problems for those responsible for identifying a new generation of terrorist threats. There are those in the field who sometimes long for the "good old days" when a "terror network" guided by Moscow could be blamed for bombings, hostage-taking, skyjacking and other forms of mayhem. Given these conditions, one faces an onerous task in attempting to assess how vulnerable the United States is to future threats and acts of terrorism. Nevertheless, such an assessment can prove useful if it can assist the analyst and those responsible for countering terrorism to look beyond the immediate threats or the latest incident. In their contingency driven, highly pressurized environment, analysts must concentrate on the collection and analysis of what is primarily tactical, combat or operational intelligence. They often lack the time to deal with strategic threats, to veer from the current requirements for narrowly focused, tactical intelligence.

What follows is a brief overview of the terrorist threat to the United States based on the application of strategic intelligence. This form of intelligence has a broader application than either operational or tactical intelligence, forms of information analysis dealing

with immediate threats. Strategic intelligence integrates politics, social studies, and the study of technology. It is designed to provide officials with long-range forecasts of what is important rather than what is urgent.[1]

THE ANALYTICAL FRAMEWORK

The analytical framework employed in this chapter will consist of the following components. The author will attempt to identify major changes in the international environment. He will then discuss how these changes create new terrorist threats in the United States. The author will then focus on probable technological/operational changes among terrorist groups. Finally, changes in terrorist motivations and goals will be examined. All of these components will then be analyzed in a strategic context to assess potential terrorist targets, operations, and resulting vulnerabilities within the United States.

THE INTERNATIONAL ENVIRONMENT

Even though it probably never fully existed, the artificial superficial equilibrium imposed by the Cold War has been destroyed. Within the former republics of the defunct Soviet Union the order imposed by Moscow on ethnic and nationalist movements has given way to separatists' demands often accompanied by political violence including terrorism, various forms of low intensity conflict, rapidly growing organized crime, and civil war. The instability has spilled over into Eastern Europe where the former satellites are attempting to cope with the uncertainties of democratization.

Additionally, now that Moscow and Washington are no longer inclined to use regional surrogates as a way of avoiding direct confrontation, a number of regional powers are emerging. Neither Moscow nor Washington have either the inclination or the influence needed to constrain many of these regional would-be superpowers. Iran is a case in point. Countries like Iran, Syria and Libya use terrorism as a form of diplomacy and as an adjunct to their foreign policies.[2] To these states, terrorism is as integral a part of their diplomacy as the exchange of ambassadors. Smaller states can easily emulate their example. In this era of what should be called a "new world disorder" the breakdown of central authority and the domination of the existing state system has been under assault from a number of quarters. First, the legitimacy of many states has been challenged by the growing assertion of both sub-national and transnational calls for "self-determination" by ethnic groups and religious movements that deny the legitimacy of what they perceive to be a discredited international order. Despite the optimism of the past, primordial loyalties have not withered away in the face of technology, democracy, and the introduction of free market economies. Indeed, many groups and movements have fed upon a reaction to what is sometimes viewed as the secular immorality of the West. Tribal loyalties on a sub-national level share the rejection of secular mass societies with fundamentalist movements. Some of these movements seem to offer the chimera of psychological, sociological and political

security to people who are trying find their place in an uncertain, even threatening, world.

New and dangerous players have emerged in the international arena. The level of instability and concomitant violence is further heightened by the rise to international political significance of non-state actors willing to challenge the primacy of the state. Whether it be the multinational corporation or a terrorist group that targets it, both share a common characteristic. They have each rejected the state-centric system that emerged 175 years ago at the Congress of Vienna. All of these factors have accelerated the erosion of the monopoly of the coercive power of the state as the disintegration of the old order is intensified. And, this process will in all probability gain even greater momentum because of the wide ranging and growing activities of criminal enterprises. These include everything from arms traders and drug cartels, which will provide and use existing and new weapons in terrorist campaigns as a part of their pursuit of profit and political power.

In sum, present and future terrorists and their supporters are acquiring the capabilities and freedom of action to operate in the new international jungle. They move in what has been called the "gray areas," those regions where control has shifted from legitimate governments to new half-political, half-criminal powers.[3] In this environment the line between state and rogue state, and rogue state and criminal enterprise, will be increasingly blurred. Each will seek out new and profitable targets through terrorism in an international order that is already under assault.

TECHNOLOGICAL/OPERATIONAL CHANGES

The remarkable changes in the international environment have been accompanied by technological changes that may have serious ramifications as regards future terrorist operations both internationally and in the United States. Up to now, terrorists have not been especially innovative in their tactics. Bombing, although not on the intended magnitude of that at the Oklahoma City Federal Building, remains the most common type of attack. Hostage taking and kidnapping are fundamental to the terrorist repertoire and skyjacking is always a possibility. Automatic and semi-automatic rifles and pistols remain the weapons of choice. However, the employment of stand-off weapons like American Stinger and Russian SA-7 hand-held anti-aircraft missiles, the U.S. Army M-72 light anti-tank weapon (LAW), and the Russian-built RPG-7 anti-tank weapon may be more readily available to terrorists than many like to believe. The same may be said of terrorist bombing technologies. Dynamite has been replaced by the more destructive and easily concealed Semtex. Furthermore, the threat has grown as a result of increased technological sophistication of timing devices and fuses. But weapons need not be sophisticated to be destructive. One only has to consider what might have happened if the pilot of the lone single-engine light aircraft which crashed into the White House had filled his plane with something as simple as a fertilizer bomb. That incident, even if it was not a terrorist act, should serve as a warning for those who are concerned with more advanced technological threats. They should remember that

smaller and more conventional instruments of destruction are still quite lethal and can have a profound affect on the targeted individual, corporation, government or what is often the ultimate target: public opinion.

A growing concern is that terrorists will cross the threshold to engage in acts of mass or "super terrorism" by using atomic, biological, and chemical (ABC) weapons. So far, the international order has been spared terrorist incidents involving nuclear weapons. Indeed, those that have been reported have turned out to be elaborate hoaxes. Fortunately, the threats have yet to be translated into actual incidents, but many believe it is only a matter of time before they are.[4] All this could easily change as a result of the disintegration of the Soviet Union. The current trade in illicit weapon's grade plutonium serves to underscore the fact that the necessary material and attendant technology will be increasingly available for those terrorist groups who may want to exercise a nuclear option, be it in the form of a dispersal of radioactive material that could contaminate a large area or the use of a relatively small but very lethal atomic weapon. The illegal trade in weapons and technology will be further exacerbated by the very real dangers resulting from the proliferation of nuclear weapons. There is good reason to fear that either a rogue state, its terrorist surrogates,or independent terrorist groups will have the capacity to go nuclear. Whether this threshold will be crossed will depend in part on the motivation, attendant strategies, and goals of present and future terrorist groups. In sum, there is every reason to be concerned that terrorists will engage in their own form of technical innovation to develop the capacity to make the nightmare of a nuclear, chemical, or biological threat move from the pages of an adventure novel to the shores of the United States.

Scenarios addressing future acts of high-tech terrorism include a wide variety of assaults on the delicate interdependent infrastructure of modern industrialized society. These scenarios move beyond the bombing or seizing of conventional or nuclear power plants to include the potentially disastrous destruction of the technological infrastructure of the information super highway. However, the scope of what constitutes a terrorist act on computers and their associated facilities is subject to interpretation. The bombing of a multinational corporation or a government's crucial computer centers could be judged an act of terrorism, but what if a terrorist hacker placed a computer virus in a very sensitive network? The results could range from the massively inconvenient to dangerous or disastrous. Such an act, however, would lack an essential element of terrorism as it is now defined: the use or threat of the use of physical violence. Nevertheless, as the technology expands so may definitions of what constitutes a terrorist act. From the terrorist's point of view the following dictum may apply, "so many new targets... so little time."

Finally, if indeed terrorism is "theater" and the people are the audience, the stage is changing.[5] CNN and other networks provide the terrorists with a potential and almost instantaneous means for spreading their message of fear and intimidation. The reality of video proliferation is just as significant as that of nuclear proliferation. Some terrorist

groups already have the ability to stage and videotape their acts, sending them out to either a broad or limited audience. They can even transmit live events through low power transmitter stations. Furthermore, the next generation of terrorists may produce highly imaginative presentations to seize the attention of a violence jaded public, one which has grown used to the now standard images of hooded terrorists holding hostages in embassies, prisons, or aircraft cabins. This kind of theater of the obscene will find a ready mass audience among those who watch the tabloid television shows and depend on the National Enquirer for their news.[6] Given the public's fascination with television happenings like the O.J. Simpson trial, one can only imagine what might happen if future terrorists direct and produce their own television spectaculars.

CHANGES IN TERRORIST MOTIVATIONS AND GOALS

There are almost certainly going to be changes in both the motivation and goals of terrorist groups. The traditional motivations for terrorism: ethnic, tribal, and religious animosities, will continue and intensify. Even while people of goodwill struggle to find solutions to problems in Northern Ireland and in the Middle East, the disintegration of the former Soviet Union and the related turmoil in the former Yugoslavia and elsewhere have engendered new groups pursuing their own varied agendas through violence, including terrorism. While much of the violence is confined to the various regions, the potential for involving surrounding states and for international assaults is significant. Even in the Middle East, where the Palestine Liberation Organization (PLO) and Israel are moving along a tortuous road toward accommodation, various factions, willing and able to engage in non-territorial terrorism, will continue to "bring the war home" to Israel and its primary supporter, the United States. Perhaps even more ominous is the growing significance of apolitical groups which resort to terrorism in pursuit of financial gain as a part of criminal enterprises. While a number of these groups may, in part, justify their actions under the rubric of political rationalization, their major goal will relate to maximizing their profits through co-opting, corrupting, and neutralizing the authority of the states in their respective countries and regions of operations. These groups, which include narco-terrorists, are particularly difficult to counteract given their vast resources gleaned by illicit trade in drugs or weapons, and because of their ability to influence, control or demoralize governments in countries where they operate. This new criminal order can engage in operations with the kind of violence that makes the old Mafia seem pacifistic by comparison.

Finally, one might anticipate that in addition to existing extremists operating according to issue-oriented movements such as radical environmentalism, fringe elements of the pro-life movement, and extremist animal rights groups, there will emerge new groups willing to use terrorism to avenge grievances both real and imaginary. These groups, which at the outset may be small and not tied to any recognized social or political movement, may have the capability to maximize their impact through the availability of a wide variety of weapons, a rich selection of targets, and the skillful use of the media and communications technology.

There will be both old and new adversaries to threaten the international order and, more specifically, U.S. interests and citizens both at home and abroad.

HOW VULNERABLE IS THE UNITED STATES AND WHAT ARE THE TERRORISTS GOALS?

The following assessment is based on integrating the analytical components presented above. The focus will be on the vulnerabilities in the United States to attacks by international terrorist or domestic groups or by such groups with domestic-international linkages. The new threat environment may see the emergence of a wide variety of sub-national and transnational groups intent on venting their frustrations with Washington for what they perceive to be a lack of support for their causes or, conversely, for supporting their adversaries. As the major military superpower, with an increased global involvement, even when engaged under the United Nations, the United States is likely to be viewed as the primary party in future disputes. Even when neutral, Washington is likely to be viewed suspiciously by one or more warring factions. In addition, when Washington moves beyond "peace keeping" to "peace enforcement"' operations, the likelihood of a reaction among one or more disputants is possible. Even though the United States may not want to be the policeman or the conscience of the world, the parties in any conflict may question whether Washington is intentionally or unintentionally pursuing a political agenda that may be counter to their objective. The result might be the spillover of violence to the United States by one or more parties in the dispute. Resort to terrorism could be a punitive action or it might be an effort to dramatize a cause. As the United States tries to redefine the formulation and execution of its foreign policy in the post-Cold War era, even if Washington is motivated by the highest of ideals, i.e., democratization, humanitarian assistance, or nation-building, those who will be the objects of such efforts might resent it. Their use of terrorism on American soil is a likely response.

The potential spillover effect may be intensified by the domestic political and economic environment. The potency of ethnic-based politics, coupled with the tendentious debates over immigration policy, may provide fertile ground by which ethnic-based conflicts from overseas may be transported to the United States. Even if that is not the case, the existence of large immigrant communities may provide the "human jungle" in which external terrorist groups can operate. The emergence of a variety of issue-oriented transnational groups could also lead extremists within their respective organizations to establish linkages with like-minded individuals or groups within the United States. Such groups could undertake joint operations against American targets in an effort to dramatize their causes or seek changes in public policy.

Cooperation between home-grown terrorists and their foreign counterparts cannot be understated. In an increasingly interrelated international environment, a new "terror network" might emerge with issue-oriented groups launching assaults on domestic targets. The threat posed by fundamentalist religious groups of all faiths cannot be

discounted. Not only Islamic extremists, but other "true believers" of a variety of faiths are likely to engage in terrorist acts against American targets. These groups might be supported or joined in their operations by domestic religious extremists. In addition, they might also seek alliances with a variety of cultists, survivalists, or neo-fascists who, for their own reasons, reject the existing social, economic, and political order and await their own versions of Armageddon.

Perhaps even more dangerous will be the resort to terrorism by apolitical terrorists who are engaged in violence and intimidation as a pant of criminal pursuits. Such groups have operated overseas with impunity. Inner-city America could become a fertile ground for their operations. They will be particularly threatening since, as a result of their illegal trade in drugs and other criminal enterprises, they may have access to vast funds with which to corrupt local authorities. What will make these groups especially dangerous may be the fact that their threats and acts of terrorism will not necessarily be meant to achieve publicity or to dramatize their cause. Such groups may use terrorist tactics in extortion attempts like those used to "shake down the neighborhood'"-only these gangs may attempt to blackmail the entire city. With their vast revenues, they could acquire a formidable arsenal of weapons with which to challenge local authorities and carry out their acts of violence on a scale not yet experienced in the United States. Furthermore, it may be very difficult for our already strained criminal justice system to address the development of new criminal cartels.

The scope and magnitude of future potential terrorist organizations will be enhanced by the rapid changes in technology that will provide the next generation of terrorists with capabilities undreamed of by the most highly dedicated and skilled terrorist of today. In a sense the capture of the infamous Carlos marked the end of an era. A new generation of terrorists armed with technologically advanced weaponry will be able to engage in violence that is more dramatic and destructive than that intended in the bombing in Oklahoma City. The threat at the lower end of the spectrum is likely to grow as well. The M-16, M-10, Uzi and AK-47 assault rifles will be supplemented by stand-off weapons like Stinger anti-aircraft missiles, LAWs and RPG-7s, already available on the world weapons market. Just because a weapon is relatively unsophisticated does not mean it cannot cause massive casualties. A stinger missile aimed at a jumbo jet as it takes off or as it approaches a large metropolitan airport could cause tremendous casualties. A LAW or RPG round lobbed into the right area of a nuclear power plant could produce catastrophic consequences.

Ultimately, the most fearful and recurrent terrorist nightmare may be drawing closer to reality. The proliferation of nuclear weapons and associated technologies, and the diffusion of knowledge needed to manufacture chemical and biological weapons, raises the fearful specter of mass destruction that makes concerns related to use of anthrax as a way of spreading both disease and panic pale to insignificance. The scary truth is that the United States is all too vulnerable to this kind of attack. The porous borders that have allowed massive illegal immigration are just as open to those who want to import new instruments of mass destruction. And, because there are

significant profits to be made, there are suppliers who are willing to provide the new generation of portable nuclear weapons, chemical and biological delivery systems despite Washington's growing concern and the improving technical means to counter such threats. Furthermore, the next generation of terrorists will have the capability of effectively exploiting the highly competitive electronic and print media both to dramatize their conventional or ABC capabilities and to extort money. Technological changes will certainly have an impact on target selection. At the outset, the availability of more sophisticated conventional explosives could enable terrorists to inflict greater damage on potential targets while lessening the risk of capture that results from having to process or transport the material. Highly symbolic targets like government buildings and corporate headquarters will be more vulnerable to attack. Major public events, like the Super Bowl or the 1996 Atlanta Olympics are also prime targets. Despite more effective physical security and technological countermeasures it will be increasingly difficult to harden potential targets. Even if the range of the weapons is relatively short, it will be a considerable challenge to expand an anti-terrorist security zone beyond the immediate periphery of potential targets like sports facilities, government buildings, or nuclear power plants. Defense in depth will require broader protective measures. Even of greater concern is the potential threat of such weapons to aviation security. While anti-skyjacking measures have been largely successful in the industrialized West, the possibility of the threat or the destruction of commercial aircraft cannot be dismissed. It is exceedingly difficult to expand a security zone beyond the confines of an airport. Moreover, stand-off weapons provide the opportunity for highly flexible hit and run attacks. The resulting mobility will make it very difficult to predict or take appropriate action against terrorists.

Finally, as potential targets continue to be hardened in urban areas, there is no reason to believe that terrorists will not seek softer targets of opportunity either in the suburbs (corporate headquarters) or rural areas (nuclear or thermal power plants and other installations). Despite these threats, it will remain difficult to develop the necessary awareness, technology and training among those corporations outside urban areas. Too many people may not take the threat seriously enough due to an "it can't happen here" syndrome. Most ominous, however, is the threat issuing from mass or super-terrorism. Cities may be held hostage by threats to poison the water supply or to disseminate any number of dangerous chemical or biological agents. Such threats must also be taken seriously given the proliferation of ABC capabilities. The threat might be overt, in which case the authorities will have the onerous task of reconciling the need to take appropriate action without creating a panic. Or the threat might be covert, in which case governments will be facing a form of nuclear, chemical, or biological blackmail unknown to the public. Finally, one can anticipate that there will be more incidents of criminal terrorism directed against senior executives, public officials, and their families. The terrorists will justify such acts of hostage-taking and kidnapping on the basis of political causation, but in many cases they will be motivated by nothing more than a desire for ransom money. There is no reason to believe that criminal extortion, which has become a major industry in Mexico and throughout Central and South America, will not be emulated within the United States. In sum, the

constellation of potential targets and the means to attack them will continue to expand in the coming decade.

The traditional motivation behind the resort to terrorism by various groups is sure to continue. Ethnic identification and hatred, the call to right perceived wrongs, and the demand for self-determination will continue to inspire terrorists. The ranks of the traditional terror mongers will be joined by religious extremist groups who have rejected what they view to be the excesses of Western and American secular society. These forces of reaction may come from the Middle East, but there will be the non-Islamic equivalents of the HAMAS and Hizbolla venting their anger and demanding the destruction of the "Great Satan." These true believers, in the conduct of what they view to be a "just war," may attack the symbols of their religious or secular rivals.

Acts such as the bombings of the Israeli Embassy and the Jewish Community Center in Buenos Aires might be emulated in Washington or New York. Moreover. domestic groups acting either independently or with the support of external terrorist organizations may launch their own assaults. One need only recall how a sectarian dispute within the United States was transformed into a mass hostage taking by the Hanafi Muslims in Washington, DC in 1977. The most alarming aspect of the religious extremists is the fact that they did not necessarily constrain their actions by using terror as a weapon to coerce or to propagandize for their causes. The new true believer, armed with the certainty of faith, may not be concerned with current public opinion or a change in the policy of an adversary. To them, being killed while undertaking an act of terrorism may be a way to paradise in the next life. The image of the smiling truck bomber driving his vehicle into the Marine barracks in Beirut may be duplicated in a large urban center in the United States. And the nightmare only becomes more horrific if such a perpetrator uses a nuclear device. While one does not want to overstate the threat, the strategic thinker must be willing to "think the unthinkable" so that appropriate responses may be conceived.

The panoply of potential attacks, save for the nuclear option or other forms of super-terrorism, will probably not create a major change in U.S. foreign policy or the articulation and pursuit of U.S. strategic interests and national security objectives. However, in this new world disorder terrorism may come to the United States whenever foreign adversaries want to test Washington's resolve in continuing its support for activities of the United Nations and friendly governments. Given the lack of coherence in the international environment and the low threshold of pain in regard to the taking of American casualties in ill-defined conflicts and the emergence of neo-isolationism, one must recognize that future acts of terrorism, if skillfully executed, might have a strategic result. The bombing of the Marine barracks in Beirut changed the course of U.S. policy toward Lebanon. That kind of act could be duplicated in the United States with even more dramatic results.

CONCLUSION

As noted at the start of this chapter, it is difficult to see through the smog of terrorism to assess America's vulnerabilities. Furthermore, it is dangerous to either understate or overstate the threat. If one minimizes the threat, little action may be taken. If one overstates it, the public and the authorities might overreact. What is needed is a realistic assessment which avoids both extremes. While recognizing that there is a threat, but not overemphasizing it, appropriate measures can be taken to lessen the likelihood of an attack. Moreover, a balanced and cautious view can assist both the public and policymakers in developing a consistent level of anti-terrorism awareness and countermeasures.

Constant awareness and preparedness are fundamental to deterring terrorists. Such a prudent approach is far better than the overreaction that might occur after an incident. In the final analysis, the United States is vulnerable to the changing terrorist threat. But the threat can be met through heightened levels of awareness, resolve, counterterrorism measures, and consistent policies.[7]

ENDNOTES

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2. Stephen Sloan, "International Terrorism: Conceptual Problems and Implications," Journal of Thought: An Interdisciplinary Quarterly, Vol. 17, No.2, Summer 1982, p.23.

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4. For a short chronology of chemical and biological incidents, see Joseph L. Douglass, Jr. and Neil O. Livingstone, "Selected List of C/B Incidents by Terrorists and Other Nonstate Actors," in America the Vulnerable: The Threat of Chemical and Biological Warfare. The New Shape of Terrorism and Conflict, Lexington Books, 1987, pp. 183-187.

5. Brian Jenkins, Intentional Terrorism: A New Mode of Conflict, Research Paper No. 48, California Seminar on Arms Control and Foreign Policy, Crescent Publication, 1976, p.4.

6. See Stephen Sloan, "Acts of Terrorism or the Theater of the Obscene, in Simulating Terrorism, Norman, OK: University of Oklahoma Press, 1981, pp. 19-28. This book illustrates how the techniques of improvisational theater in the form of highly realistic simulations were prepared and conducted to test the ability of police and military forces who are responsible for responding to terrorist threats.

7. Stephen Sloan, "US Anti-Terrorism Policies: Lessons to be Learned to Meet an Enduring and Changing Threat," Terrorism and Political Violence, Vol.5, No. 1, Spring 1993.

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TERRORISM: MOTIVATIONS AND CAUSES

Paul Wilkinson, January 1995
Canadian Security Intelligence Service
Unclassified

Editors Note:
We are pleased to welcome Paul Wilkinson to the pages of Commentary this month; many readers will already be familiar with his extensive work in the areas of political violence and international terrorism. Prof. Wilkinson is currently Head, School of History and International Relations, University of St. Andrew's, Scotland. In addition to commenting on post-Cold War terrorism in general, Prof. Wilkinson puts forth some very specific views on terrorism in the Middle East, threats from the extreme right, and issue-specific terrorism as well. He concludes with five principles "which have the best track record in reducing terrorism".

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Despite the end of the Cold War and the faltering beginnings of a peace process in the Middle East, terrorism still remains a serious threat in many countries, not surprisingly, given that the underlying causes of the bitter ethnic and religious struggles which spawn terrorism predated the Cold War, and most of these conflicts remain unresolved. While the former Soviet Union sponsored terrorism on an opportunistic basis, the idea that all international terrorism was concerted by the KGB during the Cold War is clearly an over-simplification. The overthrow of the communist dictatorships did remove an important cluster of state sponsors of terrorism. However, one of the main attractions of terrorism to its perpetrators is that it is a low-cost but potentially high-yield weapon, and it is generally possible to find weapons and cash from alternative sources, including militant supporters and sympathizers in your own home base and those living and working in prosperous countries in the West, as well as from racketeering, extortion and other forms of criminal activity, and in some cases, alternative state sponsors. Moreover, the end of the Cold War has also had a major negative effect on political violence: the removal of communist one-party rule has unleashed numerous long-suppressed, bitter ethnic conflicts.

WESTERN EUROPE

In Western Europe it is the historic separatisms of Irish republicanism in Northern Ireland and Basque nationalism in Spain that have spawned the most lethal and protracted terrorism. In Northern Ireland the IRA and Loyalist cease-fires are still holding, and the British and Irish governments and the Social Democratic and Labor Party leader, John Hume, deserve credit for their efforts towards peace. But the cease-fire is still extremely fragile, and it is going to be very difficult indeed to convert it into a lasting and honorable peace. The declared objectives of IRA/Sinn Fein and the

Unionists are as far apart as ever, and the terrorist para-militaries still have their stocks of weapons and explosives. In Spain ETA has been greatly weakened by improved Franco-Spanish police co-operation, but the terrorists show no signs of giving up.

EASTERN EUROPE

In the former Soviet Union and Eastern Europe the removal of communist dictatorship has taken the lid off many simmering ethnic rivalries and hatreds. The most horrific example of mass terror being used as weapon is Bosnia. Less well-known in the West are the conflicts in Nagorno-Karabakh and Georgia. The recent attempt by the Russian Army to suppress Chechen separatism is a dramatic reminder that the Russian Federation itself is full of ethnic groups that bitterly reject Moscow's right to rule them.

AFRICA

The most tragic examples of conflicts in which mass terror has been used are to be found in Africa. In Rwanda it has been seen on a genocidal scale, causing hundreds of thousands to flee or to face massacre at the hands of their tribal enemies. Typically, ethnic wars of this kind are waged by armed militias and are marked by extreme savagery towards the civilian population, including the policy of "ethnic cleansing" to terrorize whole sectors of the civilian population into fleeing from their homes, and the use of massacre, rape and torture as weapons of war. Ethnic conflict is the predominant motivation of political violence in the post-Cold War era. It is important to recognize that the concept of the "security dilemma", conventionally applied by realists solely to relations between states, applies equally well to the rivalries of ethnic groups. When one group looks at its neighbors and decides to enhance its weapons and security forces in the name of self-defence of the group, neighbors are likely to see such moves as a threat to their own security, and will set in train the enhancement of their own power, thus very probably triggering the conflict they sought to avoid. International spillover of such conflicts in the form of terrorist attacks in other countries will vary according to political and strategic circumstances. Where an ethnic group believes it may be in danger of being suppressed or driven out of its base area, and especially when it has militant supporters with access to weapons and explosives based in foreign countries, an international terrorist campaign is far more likely. In the late 19th and early 20th centuries ethnic conflicts in the Balkans did generate a considerable amount of"spillover" terrorism. Sikh, Tamil and Kashmiri extremists have also developed a substantial overseas infrastructure for terrorism and its logistic support. Conflicts in the Caucasus and in Central and Southern Africa, though highly lethal and protracted, have not shown these tendencies.

MIDDLE EAST

The area of conflict which has generated the most significant and ruthless spillover of terrorist violence since 1968 is, of course, the Middle East. This may seem surprising in view of the astonishing breakthrough in negotiations between Israel and the PLO,

the agreement on the Declaration of Principles in September 1993, the agreement between Israel and Jordan, and the continuing efforts by Israel and Syria, encouraged by the USA, to resolve the prolonged dispute over the Golan Heights. Nonetheless, if one defines the Middle East as including Algeria and Turkey, both of which have spawned conflicts involving considerable terrorist violence, including some international spillover, this region remains the most dangerous source of terrorist challenges to the wider international community, accounting for over 21% of all international terrorist incidents worldwide in 1992, and over 23% in 1993.

Middle East Terrorism

There are four basic motivations for terrorism in the Middle East.

1. Bitter opposition by Rejectionist Palestinian groups to the agreement between Mr. Arafat and the Israeli government. These groups see Arafat as a traitor who has betrayed the cause of Palestinian self-determination. Moreover, the dominant hard-line opposition to Arafat and Israel now comes not from the old secular Marxist revolutionary groups like George Habash's Popular Front for the Liberation of Palestine, but from the Islamic fundamentalist movements — Hamas and Islamic Jihad — driven by religious fanaticism as well as ethnic hatred for Israel. The Palestinian Islamic groups are rapidly winning mass support in the Occupied Territories at Mr. Arafat's expense. All indications are that they are likely to intensify their use of terrorism against Israeli targets within the Territories and within Israel's own borders, as the Peace Process moves forward, in a desperate effort to derail it. Most of this terrorism is likely to be mounted in Israel and the West Bank. But the recent bombings in Buenos Aires and London against Israeli and Jewish community targets, involving a massive loss of life in the case of the Buenos Aires attacks, provide tragic evidence that the Islamic fundamentalist Rejectionists, their main state sponsor, Iran, and their militant sympathizers abroad are willing and able to wage international terrorism in an effort to destroy the peace process.

2. In almost every Moslem country there are groups of extreme Islamic fundamentalists, inspired and actively encouraged by the Islamic revolutionary regime in Iran, ready to wage Jihad against pro-western Arab regimes, with the aim of setting up Islamic republics in their place. As demonstrated by the Islamic Salvation Front (FIS) and the Armed Islamic Group (GIA) in Algeria and the Islamic Group in Egypt, these groups are not confined to Shia populations. The primary targets of these groups' campaigns are the incumbent regimes and their military, police and officials and the intellectuals identified with the regime.

3. However, the Islamic fundamentalist challenge is not directed solely at incumbent regimes in the Moslem world. Frequently they widen their range of targets to include westerners within their country. For example, the GIA in Algeria has deliberately targeted French citizens in Algeria since September 1993, because they allege that France is providing covert support and assistance to the Algerian military regime, and

is historically responsible for the situation in Algeria. But, as the GIA's hijack of the Air France Airbus A300 on Christmas Eve 1994 demonstrates, the Islamic terrorist groups are also prepared to take their terrorist war to France itself. There is little doubt that the terrorists fully intended to crash the Airbus over Paris. France is, of course, not the only foreign target of such groups. All these groups are bitterly anti-American and hostile to all the Western countries.

There is a further highly dangerous aspect to the threat of Islamic fundamentalist terrorism against Western targets. The findings of the FBI and the judiciary in America indicate that the group responsible for blowing up the World Trade Center building in February 1993 was operating as a type of independent or freelance group of Islamic fundamentalists, inspired and encouraged by their spiritual mentor, Sheik Omar Abdel-Rahman, but not directly controlled by a state sponsor or other known major terrorist player. "Amateur" or "freelance" groups of this type pose a particularly difficult problem for the intelligence and police agencies, as they have no known political identity, no identifiable organizational and communications infrastructure and no previous track record. Moreover, as they are able to recruit fanatical members from the expatriate community, including those who have lived and worked in the host country for some time, the possibility exists of many such groups emerging spontaneously in western countries with substantial Moslem minority populations, such as the USA, Canada, France, Britain, Germany and Australia.

4. The Middle East is also the major region of state sponsors and supporters of terrorism: Iran, Iraq, Syria, Sudan and Libya. The position of the USA as the sole remaining superpower and the desire of President Assad of Syria to improve relations with America to gain better diplomatic leverage in the Middle East peace process have undoubtedly helped to mute Syria's terrorist efforts for the time being. But Damascus has not discarded this weapon: it is still giving safe haven to a variety of groups which it might be useful to unleash at some future time. Meanwhile, Iran remains far and away the most important state sponsor. As mentioned above, it is the leading sponsor of Islamic and Palestinian Rejectionist groups, and provides them with weapons, funds, training and intelligence. Nor are their sponsorship activities confined to the Middle East and Western Europe. They have been extremely active in Pakistan and Turkey, for example, and have been linked to the car bombing of the Israeli Embassy in Buenos Aires on 17 March 1992, in which 29 people were killed and 242 injured. In addition to using terrorism as a weapon to back Islamic fundamentalism and Palestinian Rejectionism, Iran has over a considerable period targeted Iranian dissidents abroad. Iranian operations have been linked to the murders of dissidents in France, Germany and Switzerland. The Iranian regime also continues to uphold the fatwa, issued by Ayatollah Khomeini in 1989, condemning Salman Rushdie to death for his alleged blasphemy against Islam in his book The Satanic Verses. A government-backed Iranian foundation has offered a reward of $2 million for the killing of Rushdie. Meanwhile attacks on publishers, translators and bookshops involved in disseminating Rushdie's works continue, and it would be foolish to assume that any country is immune from attempts to carry out such threats.

Iraq remains potentially the most dangerous of the other state sponsors, though its efforts to persuade the international community to lift UN sanctions against Iraq and its preoccupation with internal reconstruction in the wake of the Gulf War have recently muted its activities in this direction.

Demise of left-wing terrorism

Extreme left ideological motivation for terrorism has undergone an almost complete eclipse in Europe. The West German authorities had already broken the back of the Red Army Faction by the mid- 1980s; the Italians have totally defeated the Red Brigades; and France and Belgium suppressed Direct Action (AD) and the Combatant Communist Cells (CCC) respectively. The only NATO countries with a serious domestic challenge from extreme left terrorism are Greece (17th November and ELA), and Turkey (DevSol). The demise of these groups was undoubtedly hastened by the growing professionalism of the response of the intelligence and police services and judicial authorities in the countries concerned, by imaginative modifications of temporary anti-terrorism law, such as the Pentiti legislation in Italy, and by the discrediting of Marxist-Leninist systems and their overthrow of 1990. However, it is a mistake to write off the continuing influence of extreme left ideologies on revolutionary movements elsewhere. For example, the Shining Path movement in Peru undoubtedly sees itself as the true heir to Maoism and aspires to being the vanguard of a communist evolution in Latin America. Despite its setbacks since the capture of its founder, Guzman, the movement still poses a serious threat to life and economic and social wellbeing in many parts of the country, and is serving as a model for other violent groups in neighboring countries. The Shining Path is a peculiarly inappropriate name for a movement which has killed and injured thousands of its countrymen. But its lethality pales in comparison with the mass terror of the brutal Cambodian communist movement, the Khmer Rouge. Although it has suffered many major setbacks since the start of the UN peacekeeping operations in Cambodia, it is still fighting the Cambodian government forces in the northwest of the country, and is still able to use the border with Thailand and covert collaboration and smuggling activities with corrupt Thai generals.

Threats from the extreme right

The threat of violence from the extreme right has been present in many countries for decades. Neo-fascists and neo-nazi groups have been active in the United States, Canada, South Africa and Central and South America, as well as in Europe and the former Soviet Union. In South Africa extremist groups such as Afrikaner Weerstandsbeweging (AWB) still constitute a threat to life and social and economic wellbeing, and have shown themselves capable of political assassinations aimed at destabilization. In Europe the problem of the resurgence of extreme right-wing violence has become a far more serious threat than ideologically motivated violence from the extreme left in the past few years. For example in Germany, the widespread

disillusion with mainstream political parties, the strains of reunification on the economy, high levels of unemployment and the arrival of hundreds of thousands of immigrants have created a climate in which violent right-wing extremism thrives. In 1992 there were over 2,000 attacks by extreme right groups, causing 17 deaths and over 2,000 injured. The German Interior Ministry estimates there are some 75 extreme right groups active in Germany with 65,000 activists, roughly 10% of whom have a record of violence. Between 1991 and 1993 the extreme right groups killed 30 people. In September 1993 Chancellor Kohl rather belatedly condemned the rise of these groups and their violent actions, and said they were as much of a threat to democratic society as extreme left-wing terror had been in the 1970s and early 80s. Extreme right violence from skinhead and racist thugs has also been on the increase in other parts of central, Eastern and Western Europe, from Russia in the East to Britain in the West. In Russia, Zhirinovsky's extreme right Liberal Democratic Party, and similar groupings, have the potential to generate violence on the streets. Nor is it safe to assess the danger from the extreme right purely in electoral terms. Pin-stripe neo-fascist parties have done surprisingly well in elections in Italy, Austria and several other continental countries, but in Britain, where the electoral performance of the extreme right has been abysmal, the incidence of racist attacks has grown dramatically, with a doubling of racist incidents recorded by the police over the past five years. Violent attacks motivated by extreme right ideology are likely to increase over the next few years in many countries where conditions are conducive. However, extreme right- wing terrorism is likely to remain indigenous, and shows no signs of developing a significant international dimension.

Issue-specific terrorism

Issue-group extremists are another growing source of terror violence. Recent escalations in attacks against medical staff, clinics and hospitals by anti-abortion campaigners in the USA, and against research scientists, laboratories and commercial premises by animal rights campaigners in the UK, are indications of the kinds of motivation involved. Although issue-group extremists aim at changing specific policies or practices rather than the whole socio-political system, their potential for endangering life and social and economic wellbeing should not be underestimated. For example, they have shown considerable sophistication in tactics, such as the use of product contamination and computer sabotage. Issue-group motivated terrorism shows every sign of increasing in the heavily urbanized pluralist democracies, with their complex and vulnerable systems of communications, transportation, electronic funding transfers, etc.

Likely target groups

On the basis of a statistical analysis of trends in targeting by international terrorist groups over recent years, it is not difficult to assess the most likely targets in coming years. Over half the attacks on property/facilities are likely to involve business or industrial premises, roughly 10% are likely to involve diplomatic premises, and about

5% will involve other government premises and military facilities.

It is important not to rely too heavily on terrorism incident statistics, as they do not bring out the qualitative differences in the effects of specific terrorist attacks. For example in the international terrorism figures for 1993, the single event of the World Trade Center bombing accorded North America the highest number of victims wounded by international terrorist activity in any region of the world. Yet this does not accurately reflect the characteristic distribution of terrorist victimization internationally. In view of the fact that attacks by terrorist groups have become increasingly lethal over recent years, it is wise to plan for a continuing trend towards massive car and truck bombings in crowded city areas, and "spectacular" terrorist attacks, for example on civil aviation, airport facilities or military or diplomatic facilities, designed to capture maximum attention from the mass media, to cause maximum shock and outrage and to effect some terrorist demands.

Conclusion

Faced with this scenario of future terrorism, what are the prospects of European states achieving radical improvements in their measures to combat terrorism up to 2010 and beyond? The true litmus test will be the Western states' consistency and courage in maintaining a firm and effective policy against terrorism in all its forms. They must abhor the idea that terrorism can be tolerated as long as it is only affecting someone else's democratic rights and rule of law. They must adopt the clear principle that one democracy's terrorist is another democracy's terrorist. The general principles which have the best track record in reducing terrorism are as follows:

•no surrender to the terrorists, and an absolute determination to defeat terrorism within the framework of the rule of law and the democratic process;
•no deals and no concessions, even in the face of the most severe intimidation and blackmail;
•an intensified effort to bring terrorists to justice by prosecution and conviction before courts of law;
•tough measures to penalize the state sponsors who give terrorist movements safe haven, explosives, cash and moral and diplomatic support;
•a determination never to allow terrorist intimidation to block or derail international diplomatic efforts to resolve major political conflicts in strife-torn regions, such as the Middle East. In many such areas terrorism has become a major threat to peace and stability, and its suppression therefore is in the common interests of international society.

To conclude on an optimistic note, one major aspect of advanced technology gives the democratic governments a potentially winning card in their battle against terrorist organizations. Whereas developments in terrorist weaponry and the vulnerability of modern complex societies help the terrorists, the development of sophisticated fine-grained computers and terrorism databases provide superb assets for the intelligence

war against terrorism. If these developments are matched by greatly enhanced international intelligence sharing and counter-terrorism collaboration, they can lay the foundations of long-term success over terrorist organizations.

The views expressed herein are those of the author, who may be contacted by writing to :

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THE THREAT OF CHEMICAL/BIOLOGICAL TERRORISM

Ron Purver, August 1995
CANADIAN SECURITY INTELLIGENCE SERVICE
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Editors Note:
Readers of previous Commentary issues will recall Mr. Ron Purver's contributions to the topics of smuggled nuclear materials and the transfer of conventional armaments. In this issue, Mr. Purver examines existing research on the subject of chemical and biological (CB) terrorism in light of the recent attacks in Japan, and proposes answers to a number of questions: what characteristics of CB agents might incline terrorists to their use? What degree of expertise is required? Which kind of terrorist group would be most likely to use CB agents? What type of agents would they be? How would they be obtained and delivered? These and a series of related concerns lead the author to some interesting conclusions about the likelihood of future attacks, and in short, about the reality of the threat posed by CB terrorism.

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Terror in Tokyo: Advent of a New Age?

On 20 March 1995, at the height of the morning rush hour, five teams of two people each boarded cars on three main lines of the Tokyo subway system. The trains were all scheduled to arrive at the Kasumigaseki Station, in the heart of the capital's government district, between 8:09 and 8:13 a.m. While one member of each team kept a lookout, the other placed a package wrapped in newspaper on the overhead rack or floor of the subway car, then, using a needle-tipped umbrella, punctured holes in plastic pouches containing the ingredients of a deadly gas, sarin. As the gas formed and began to spread through the cars and stations at which they stopped, thousands of commuters were overcome. In all, 12 people died and over 5,500 were injured, some permanently scarred. Two of the subway lines were temporarily shut down and no fewer than 26 stations closed. In the weeks that followed, up to one-third of Japan's total police force—as well as many military units—were mobilized to track down the perpetrators and prevent a recurrence. Perhaps most important, the Japanese national "psyche" received a devastating blow as the citizenry—long accustomed to peace and good order—lost confidence in the ability of its government to provide the most basic personal security.

The chemical attack on the Tokyo subway came as no great surprise to many specialists in world terrorism, however. For over two decades, prominent experts have been warning that terrorist groups could resort to the threat or use of mass-destruction,

chemical or biological weapons against civilian populations. While such weapons had been used (or threatened) in isolated, relatively minor instances in the past, the Tokyo attack marked the first occasion of their use in a large-scale, indiscriminate assault on a major urban area1. As such, it immediately raised fears of "copycat" attacks by other groups elsewhere in the world, inaugurating a whole new dimension of international terrorism.

Toxicity

One of the principal advantages of CB weapons for terrorists is their extreme toxicity, which at least theoretically provides the capability for mass-destruction attacks using comparatively small quantities of agent. Certain biological agents are the most toxic of all, approximating the lethality of a nuclear explosion in terms of the potential number of casualties caused. For example, type-A botulinal toxin, or BTX, with a mean lethal dose estimated to be as low as a few tenths of a microgram, has been described as "the most lethal substance known" (Kupperman, Robert H., and David M. Smith, "Coping With Biological Terrorism," in: Roberts, Brad (ed.), Biological Weapons: Weapons of the Future? pp. 35-46, Washington, DC: Center for Strategic and International Studies 1993). One source states that "one-half ounce, properly dispersed, could kill every man, woman, and child in North America" (Livingstone, Neil C. The War Against Terrorism. Lexington, MA: Lexington Books, 1982); another that just eight ounces of the substance could "kill every living creature on the planet" (Mullins, Wayman C., "An Overview and Analysis of Nuclear, Biological, and Chemical Terrorism: The Weapons, Strategies and Solutions to a Growing Problem." American Journal of Criminal Justice 16:2, 1992, pp. 95-119.)

Some authors maintain that anthrax is an even more deadly agent. According to one study, in principle, if its spores were distributed appropriately, a single gram would be sufficient to kill more than one-third of the population of the United States. Of course, it is often pointed out that an attack of such magnitude would not be practically feasible. However, more realistic, smaller-scale scenarios still posit large numbers of casualties. For example, the U.S. Law Enforcement Assistance Administration in March 1977 warned that a single ounce of anthrax introduced into the air-conditioning system of a domed stadium could infect up to 80,000 spectators within an hour. And a 1972 study by the Advanced Concepts Research Corporation of Santa Barbara, California, postulated that an aerosol attack with anthrax spores on the New York City area could cause more than 600,000 deaths. Some indication of the scale of casualties to be expected from a deliberate attack can be gained from the fact that the accidental release of anthrax in Sverdlovsk, Russia, in 1979 is estimated to have killed between 400 and 1,200 people.

An attack using chemical weapons, while generally less destructive, could still cause thousands of casualties. The most lethal of the chemical agents are the nerve gases. According to one source, a small quantity of the nerve agent sarin can produce a vapor concentration high enough to kill someone with a single breath. The nerve

agent VX is even more toxic, with the amount one can place on the head of a pin being sufficient to kill a human being. In the Tokyo subway case, analysts have attributed the relatively small number of fatalities to a variety of factors: the deliberate dilution of the agent, to provide protection for the attackers and facilitate its subsequent spread; the small quantity of chemicals used; the rapid response of emergency personnel; and the unusually powerful air exchange systems of many Tokyo subway stations.

As the Tokyo case demonstrates, clearly one must be careful of extrapolating directly from individual lethal doses to estimates of mass casualties, given the difficulties encountered in effective dissemination. Nevertheless, chemical and biological agents must still be considered as viable weapons of mass destruction, as well as being useful in "lesser" roles, for terrorists.

Other "advantages" of CB weapons

A number of other factors are said to favor the acquisition of CB weapons by terrorists, particularly in comparison to nuclear weapons. Some of these are related to the toxicity issue just discussed. For example, the smaller quantities of agent needed on account of their lethality help reduce the costs and complexity of their production or acquisition by other means. This in turn eliminates the need for a large infrastructure of personnel and facilities, which in turn eases the problem of security and avoidance of detection. It also allows for most chemical and biological agents to be transported from one country to another in a container as small and seemingly innocuous as a bottle of wine or a thermos.

Other advantages of CB weapons include their undetectability by traditional anti-terrorist sensor systems (and hence by conventional countermeasures); the time-lag (in many cases) between release of an agent and its perceived effects on humans, allowing the perpetrator(s) to escape; in at least some cases, the lack of an agent "signature," enabling an assassin, for example, to disguise the cause of death; their adaptability to small demonstration attacks as an indication of resolve and ability to carry out the threat of a much more devastating attack; their capacity—unobtainable by other means—to inflict heavy casualties on the military forces of a state or to damage its economy seriously; the degree of sheer terror (and hence societal disruption) that may be instilled in a target population, due to the particularly insidious nature (microscopic and, in some cases, colorless and/or odorless) of the agents in question; and the relative ease and cheapness of their production or other acquisition, particularly in comparison with nuclear weapons.
One author estimates the start-up costs to produce a biological weapon at less than $1 million. Another points out that "a sophisticated program designed to produce a fissionable device would probably cost hundreds of millions of dollars, whereas type A botulinal toxin, which is more deadly than nerve gas, could be produced for about $400 per kilogram. A group of C/B experts, appearing before a UN panel in 1969, estimated that 'for a large-scale operation against a civilian population, casualties might cost about $2000 per square kilometer with conventional weapons, $800 with

nuclear weapons, $600 with nerve-gas weapons, and just $1 with biological weapons'" (Douglass, Joseph D., Jr., and Neil C. Livingstone. America the Vulnerable: The Threat of Chemical and Biological Warfare. Lexington, MA: Lexington Books, 1987.) Another source estimates that the production of 1,000 kilograms of sarin (GB) nerve agent in a small laboratory would cost about $200,000. However, it is unclear if such estimates take into account the added costs that might have to be paid to procure equipment and/or materials on the black, as opposed to the open, market.

Requisite capabilities

The ease of manufacture of CB weapons derives from the widespread availability of many of the materials and of the necessary technical knowledge, together with the fact that a single individual or small group with relatively limited expertise is capable of producing and employing such a weapon. One author maintains that "manufacturing a lethal bacterial disease agent requires little more than chicken soup, a flat whiskey bottle and an available source of seed culture" (Roosevelt, Edith Kermit, "Germ War." International Combat Arms (July, 1986), pp. 38-42.); another describes the process as being "about as complicated as manufacturing beer and less dangerous than refining heroin" (Douglass and Livingstone 1987: 23).

It is often noted that both the USA and Britain have declassified, and even published, the formula for making VX nerve gas. The techniques for making nerve agents are similar to those used for insecticides, "and in some cases may simply involve taking as intermediate products insecticides or other chemicals that can be purchased commercially and putting them through one additional chemical reaction" (Hurwitz, Elliott, "Terrorists and Chemical/Biological Weapons." Naval War College Review 35:3 (May-June), 1982, pp. 36-40.) Thus, for example, according to one author, "ball-point pen ink is only one chemical step removed from sarin" (Mullins 1992: 108-9). The open sources do differ somewhat on the precise level of expertise required to produce CB warfare agents—whether it could be done by a high-school student or undergraduate or would require a graduate student or small team of professional scientists, for example. There is also some disagreement over whether a single individual could adequately handle the task, including that of dissemination, or whether this, again, would require some teamwork— especially between those with a scientific bent and those with practical, operational terrorist experience.

The effort by the Japanese Aum Shinri Kyo religious sect, responsible for the Tokyo and other gas attacks, was clearly a massive and long-term one. The sect went out of its way to recruit science graduates of the most prestigious Japanese universities, and invested immense amounts of resources in equipment and materials for what was planned to be a nationwide assault on the Japanese government and people. However, this case should not obscure the fact that much smaller, though perhaps necessarily equally dedicated, programs by other terrorist groups could also achieve mass casualties, not to mention disruption on a lesser scale.

Candidate groups

The terrorist groups previously thought to be most predisposed to the use of CB weapons included those with vague, universalistic goals and undefined constituencies (such as the Japanese Red Army and Red Army Faction); those unconcerned with the effects on public opinion (such as neo-Nazi groups in Europe and North America); those with a history of high-casualty, indiscriminate attacks (such as the JRA, Sikh extremists, pro-Iranian Shiite fundamentalist groups such as Hizbollah, and extremists within the Palestinian movement such as the Abu Nidal Organization); those noted for their sophistication in weaponry or tactics (such as the Popular Front for the Liberation of Palestine—General Command); those with a demonstrated willingness to take risks; and those with state sponsors, especially where the latter are known to possess CB weapons themselves.

Likely types of agents

The number of different types of CB agents that potentially could be used by terrorists is staggering. However, those most likely to be used include, among the biologicals, anthrax, botulinal toxin, and ricin; and among the chemicals, various insecticides, hydrogen cyanide or mustard gases, and nerve agents such as sarin, tabun or VX. Even less toxic substances, such as off-the-shelf insecticides or household cleaning agents, could be used, however. Some authors also point to the danger of genetically engineered organisms, but most consider these to be too sophisticated and hence rather unlikely for terrorist use. CX or phosgene oxime, one of the original chemical warfare agents which once featured prominently in the Soviet chemical weapons arsenal, "is...now more widely known simply as a toxic industrial chemical and, as such, it is manufactured, stored, shipped, and sold throughout the United States like dozens of other toxic chemicals" (Douglass and Livingstone 1987: 16).

Regarding biological agents, experts believe that terrorists would be more likely to choose a bacteriological rather than a viral or rickettsial agent, since rickettsial infections can be readily treated with antibiotics and viruses are more difficult than bacteria to cultivate and often do not live long outside a host, making them more difficult to disseminate effectively. Some toxins have the advantage of being more stable, with some being both relatively simple to manufacture and extremely toxic. Anthrax spores are "attractive," among other reasons, for their relative hardiness against adverse environmental conditions, as shown by their ability to survive for decades on the Scottish island of Gruinard after biological warfare experiments during World War II.

Experts disagree over whether CB terrorists are more likely to prefer chemical over biological agents, some insisting that the former are cheaper and easier to manufacture and use, others that the latter are more easily acquired and could produce a higher number of casualties. Certainly, chemical weapons appear to be more "controllable," posing less danger to their users and being less likely to cause

unintended damage, thus allowing for more precise and discriminate attacks. Chemical agents are also more readily available commercially or by theft from military or civilian stockpiles. If the comparative advantages of chemical and biological agents are not always clear cut, however, those between chemical and biological weapons on the one hand, and nuclear weapons on the other—in regard to such aspects as ease of manufacture or other acquisition, as well as selectivity in targeting—appear obvious.

Means of acquisition

Apart from manufacturing it them selves, terrorist groups could acquire CB agents by (in some cases) purchasing them directly from legitimate suppliers; stealing them from research facilities or military installations (which are said to be less well-guarded than their nuclear counterparts); or receiving them from foreign state sponsors. Many hazardous substances suitable for use directly as chemical or biological weapons are commercially available with minimal, if any, restrictions. Most likely biological agents occur naturally in the environment. Specimens can also be obtained by mail from the American Type Culture Collection in Maryland or other, similar collections around the world. For example, anthrax specimens can be purchased for about $35, according to one author. He complains that "marijuana is more closely regulated in the United States than access to and distribution of most deadly biological cultures" (Douglass and Livingstone 1987: 24). Some state sponsors of terrorism have active chemical-biological warfare programs, and many analysts speculate that terrorists could obtain such weapons directly in this way. However, other analysts maintain that state sponsors would be unlikely to provide their clients with such weapons for fear of retribution, and that state sponsorship of terrorist groups may thus act as a kind of brake on their use of CB agents. Theft from the existing large stockpiles of chemical weapons worldwide is another matter, however. According to one source, "the U.S. government [has] acknowledged that a small amount of its inventory of VX is presently unaccounted for" (Livingstone 1982: 111). The Japanese case surprised some observers insofar as the terrorists in question went to the trouble of themselves manufacturing a relatively sophisticated nerve agent, rather than using somewhat less toxic, but still potentially deadly, off-the-shelf chemicals. This undoubtedly had to do with the Aum Shinri Kyo's fascination with science and extreme insistence on self-sufficiency. But, once again, this should not obscure the fact that other groups could resort to simpler, short-cut methods of acquiring chemical or biological agents that could still have a devastating impact on their target populations.

Means of delivery

The effective dissemination of CB agents by terrorists is widely considered to be more difficult than their manufacture. CB agents could be delivered to their targets in a myriad of ways, but the most likely are through contamination of foodstuffs or liquids, or as vapor or via aerosol within a relatively enclosed area. Some authors also consider a wide-area attack using aerosol generators to be credible. However, the popular scenario involving the poisoning of the water supply of a major population

center appears less feasible, given the large quantities of agent that would be required and the various filtering or purification measures already in place. On the first point alone, for example, it has been estimated that it would take no fewer than 14 billion lethal doses, or 600 metric tons, of chemical fluoroacetates to contaminate effectively the drinking water in a typical 4 billion-gallon reservoir. On the other hand, the water supply for a discrete installation could be vulnerable, as would be the air conditioning systems of even quite large public buildings or tunnel networks, such as subways. Similarly, domed sports stadiums have been described as "ideal" targets for a terrorist CB attack intended to kill tens of thousands of people. In regard to the general issue of dissemination, several observers have pointed out that, had the Tokyo attackers employed a more efficient delivery system, such as an aerosol, or struck under different environmental conditions—such as a hot afternoon favoring quicker evaporation—the number of fatalities in the Japanese case would have been much higher.

Incidents of past use or threat

It is important to distinguish here between threat and actual use, as well as between the use of such agents for purposes of mass destruction, and their use in smaller, more limited attacks. It is true that, until the Tokyo attack, there were no reported cases of the use of CB agents by terrorists in a mass-destruction attack on civilians, except possibly the contamination of restaurant food in Oregon with salmonella typhi, which resulted in the poisoning of 750 people (but no fatalities). However, there had been previous reports of terrorist threats to use CB weapons in mass-destruction attacks, as well as both failed and successful attempts by them to acquire such agents, for whatever purpose; and their actual, "successful" use in some, relatively limited, instances (such as product contamination and individual assassinations).

Among the most serious incidents reported in the past were a 1970s attempt by the Weather Underground to acquire biological agents from the US Army's biological weapons facility in Fort Detrick, Maryland; the 1980s discovery of a Red Army Faction "safe house" in Paris containing quantities of botulinal toxin; the above-mentioned Oregon case, involving the Rajneesh cult; a number of assassinations or attempted assassinations using ricin-tipped umbrellas; the "Alphabet Bomber's" threat to kill the American president with nerve gas; the 1980 discovery of an RAF safe house in Germany containing several hundred kilograms of organophosphorous compounds; the 1975 theft of a large quantity of mustard gas from an American ammunition bunker in West Germany, followed by threats of its use by the Baader-Meinhof Gang against Stuttgart and possibly other cities; the 1970s contamination of Israeli citrus fruit exports to Europe with liquid mercury, resulting in severe economic losses to Israel; and similar threats of contamination of South African products, also resulting in their removal from the market.

While Canada has not experienced any major, mass-casualty incidents of chemical or biological terrorism, there have been threats to contaminate the water supplies of

various localities, as well as claims of produce contamination resulting in substantial economic losses as products were withdrawn from the market. For example, a group called the Animal Rights Militia (ARM) claimed in January 1992 to have injected oven cleaner into "Cold Buster" candy bars in Edmonton and Calgary, in protest against the developer's purported use of animals in research. Although nothing more than a non-poisonous saline solution was detected, the distributor immediately recalled tens of thousands of the bars from some 250 outlets in British Columbia, Alberta, Saskatchewan, and Manitoba, and the manufacturer halted production, forcing the temporary lay-off of 22 employees. In a similar incident, the same group caused thousands of frozen Christmas turkeys to be withdrawn from the shelves or returned by customers in the Vancouver area in December 1994.

Reasons for non-use

While the above-cited cases provide ample evidence of terrorist interest in acquiring CB weapons, as well as their occasional use in the past, the comparative infrequency of such use (and, until recently, the virtually total absence of mass-destruction attacks of this kind) could be considered surprising, given the factors noted earlier. A number of authors have speculated about the possible reasons for this phenomenon. Among the most plausible are fears engendered by the assumed uncontrollability of the agent, including the possibility of harm to the user; related to this, the unpredictability of the consequences of use—whether it will "work" at all, or only too well; political disutility, given the likelihood of alienating supporters or potential supporters on moral grounds; fear of the possibly unprecedented governmental retribution that might follow; the lack of a perceived need for such indiscriminate, high-casualty attacks in furthering the goals of a group; (until recently) the lack of a precedent; and a general reluctance to experiment with unfamiliar weapons.

Current trends/Likelihood of future use

Despite the relatively low incidence in the past, and even before the Tokyo attack, many authors believed that the likelihood of future use of CB agents by terrorists was considerable and growing, given trends such as the following: increased security against traditional types of terrorist attacks; public indifference to the latter, requiring ever-more spectacular acts to attract attention; a recent increase in high-casualty, less discriminate attacks; the growth of state-sponsored terrorism, combined with the proliferation of CB weaponry and materials worldwide; an increase in inter-ethnic and religiously-inspired violence, with fewer humanitarian inhibitions; and the availability of materials and weapons expertise from the former Soviet Union and its allies (including the growth in organized crime in such countries). Despite some disagreement as to the precise likelihood of the future use of CB weapons for mass destruction by terrorists, most authors agreed that such an eventuality was more likely than that for nuclear weapons; that, given the magnitude of the possible consequences, the threat had to be taken seriously and prepared for; and, finally, that the first actual occurrence was likely to spawn imitative attacks, thereby

increasing the likelihood of subsequent use.

The March 1995 Tokyo attack did in fact set off a wave of apparently imitative attacks, some causing hundreds of casualties, particularly in the Yokohama area (there were also subsequent, unsuccessful attempts at mass-destruction terrorism attributed by police to the Aum Shinri Kyo). So far, however, such attacks appear not to have spread beyond Japan. While the Tokyo subway incident certainly provides a shocking example of what a terrorist group can accomplish, its implications for the future use of CB agents by terrorists are somewhat mixed. On the one hand, despite the extraordinary amount of effort over a long period devoted to the task by Aum Shinri Kyo (using a scale of resources likely unavailable to most other groups), its actual results must have been somewhat disappointing, from its point of view. The initial attack on Tokyo, while creating widespread chaos and apprehension, caused relatively few fatalities among the civilian population. Earlier attempts at individual assassinations reportedly met with mixed success. Subsequent attempts at mass-destruction terrorism by releasing hydrocyanic gas in the Tokyo subways were complete failures. Far from diverting attention from its other activities or causing the Japanese government to back off from its then on-going investigation of the cult (two possible motivations for the initial attack that were widely attributed to Aum), the Tokyo incident brought down the kind of massive, unprecedented government suppression of its activities that many analysts had predicted would face any terrorist group resorting to the use of CB agents against civilians.

On the other hand, it is true that an important precedent has been set. As one leading terrorism expert, Brian Jenkins, put it: "It breaks a taboo and has psychological import. Others will ask whether such tactics should be adopted by them. It is now more likely that at least some will say yes." To the extent that the attack was successful in creating enormous disruption with relatively modest effort (in terms of the 20 March attack itself), it may indeed encourage others to follow in Aum Shinri Kyo's path. And to the extent that it and subsequent attempted attacks have failed, other terrorist groups may have learned valuable lessons from Aum's "mistakes" that could serve them well in similar actions of their own in future. While calling the attention of other terrorist groups to the CB "option," however, the chemical attacks in Japan have at the same time served to heighten official awareness of the problem, increasing pressure on governments to explore defensive measures and, in particular, to co-operate with one another in preventing or mitigating such atrocities in future.

Defense against CB terrorism

Defense against CB terrorist attack is quite problematic for a host of reasons, many of which have already been alluded to. These include the lack of early-warning systems against biological agents; the large number of potential CB agents (including some that may be unknown to the defender); the large number and diversity of potential targets; the dual-use nature of many of the agents and of the equipment used to produce them, making stricter regulation more difficult; the wide availability of such

materials; the ease of their concealment; the limitations of protective equipment such as gas masks, and so on.

Nevertheless, a number of measures have been proposed to help deter, or at least mitigate the consequences of such attacks. These include the development of better early-warning sensors for biological agents; enhanced and more coordinated efforts at intelligence collection; tightening the regulations for acquisition and use of CB agents and/or the equipment needed for their manufacture; increased training of local police and law-enforcement officials; public education; research, development, and stockpiling of vaccines, antidotes, and antibiotics, etc.; filter mechanisms in large public buildings; denial of access to sensitive installations; development and wider availability of more "user-friendly" protective equipment; and better contingency planning, including the creation of task forces analogous to the American Nuclear Emergency Search Team. As examples of the current inadequacy of defenses against CB terrorist attack, one author warns that there is only one manufacturer of anthrax vaccine in the entire United States. As for the identification of unknown agents, it has been pointed out that in 1976 it took the full resources of the American government no fewer than seven months to isolate the Legionnaires' disease bacterium after it was discovered. The difficulties of providing large populations with passive protection against CB attack were well-illustrated in the case of Israel during the Gulf War.

In Canada, a Special Threat Assessment Group (STAG) was formed in 1976 as an interdepartmental committee to assess, prevent, contain or otherwise assist in the response to terrorist threats and incidents involving the use of nuclear, biological, or chemical agents. Chaired by an official of Health Canada, it is comprised of medical professionals and scientists charged with assessing a threat's credibility, feasibility, magnitude and potential or likely consequences, as well as helping to identify the medical and physical resources required to respond. In addition, there is a Nuclear, Biological and Chemical (NBC) Response Team belonging to the Canadian Forces, attached to the NBC School at CFB Borden, Ontario. It is capable of providing on-site advice and technical assistance in isolating, containing, and assessing the hazard; providing any necessary first aid and removal of casualties; collecting and packaging samples for later analysis; and supervising decontamination or clean-up operations. It has conducted a number of exercises and co-operative training with the RCMP and other authorities, and would be activated upon a request from the federal Solicitor General.

Historically, much less attention has been paid to the CB terrorist threat than to its nuclear counterpart, despite the cogency of the argument that the latter is less serious than the former. Recently, a number of initiatives have been launched to improve government preparedness against the CB terrorist threat, including the creation of an interdepartmental Nuclear Biological Chemical (NBC) Working Group in the US, and internationally-coordinated research efforts and joint exercises. Not much is publicly known about these activities, for obvious security reasons. However, enough is known to suggest that much remains to be done, both nationally and internationally, in order

to meet this apparently increasingly dangerous threat.

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1 A sarin attack on the Japanese town of Matsumoto the previous summer, eventually attributed to the same religious sect as that responsible for the Tokyo atrocity, was much smaller in scale (though still causing several deaths and hundreds of other casualties), and apparently directed at particular individuals.

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THE CONTINUING THREAT FROM WEAPONS OF MASS DESTRUCTION

Dr. Gordon C. Oehler, March 27, 1996

Statement for the Record by Dr. Oehler, Director, Nonproliferation Center to the Senate

Table of Contents

Overview
The Threat of Nuclear Diversion
The Growing Chemical and Biological Weapons Threat
Iraq: A Country Study
•Iraq's Chemical Warfare Program
•Iraq's Biological Warfare Program
Efforts to Control Weapons Proliferation
Intelligence Community Response
Strategic Planning Process
Intelligence Successes to Date
Appendix A--Chronology of Nuclear Smuggling
Appendix B--Chemical Agents
•Types of CW Agents
•Production of CW Agents
•Methods of Delivery
Appendix C--Biological Agents
•Types of BW Agents
•Production of BW Agents
•Methods of Delivery

Overview

The Director of Central Intelligence, John Deutch, recently described a number of troubling developments in the world. He noted that the increasingly troubled post-Cold War world has, in a curious way, made us yearn for the dark days of the 1960s and 1970s when we knew the kind of target we were dealing with and the problems we were facing. One reason for this is that not only a number of sovereign states, but now individual groups, have become willing to buy or sell the technologies necessary to produce weapons that could have devastating effects on economic or population centers. Although the threat of a nuclear attack involving hundreds or perhaps thousands of weapons from the former Soviet Union has diminished, another threat has arisen: the potential acquisition of nuclear materials or even nuclear weapons by states hostile to the United States or by terrorists intent on staging incidents harmful to US interests. We currently have no evidence that any terrorist organization has obtained contraband nuclear materials. However, we are concerned because only a small amount of material is necessary to terrorize populated areas. The chilling reality is that nuclear materials and technologies are more accessible now than at any other

time in history--due primarily to the dissolution of the former Soviet Union and the region's worsening economic conditions. This problem is exacerbated by the increasing diffusion of modern technology through the growth of the world market, making it harder to detect illicit diversions of materials and technologies relevant to a nuclear weapons program. As you know, many of the technologies associated with WMD programs, especially chemical and biological technologies, have legitimate civilian or military applications unrelated to WMD. For example, chemicals used to make nerve agents are also used to make plastics and to process foodstuffs; trade in those technologies cannot be banned. As dual-use technology and expertise continue to spread internationally, the prospects for chemical and biological terrorism increase. The relative ease of production increases our concern that the use of both chemical and biological weapons is attractive to terrorists. Moreover, the proliferation of WMD to more and more nations has increased the possibility that one or more of these states may choose to provide such weapons to terrorists. At least as worrisome is the likelihood that terrorist groups or cults can acquire or develop chemical and biological weapons on their own. The incidents staged in March 1995 by the Japanese cult Aum Shinrikyo demonstrate that the use of WMD is no longer restricted to the battlefield. Japanese authorities have determined that the Aum was working on developing the chemical nerve agents sarin and VX. The Aum was able to legitimately obtain all of the components that it needed to build its massive chemical and biological infrastructures. However, terrorist groups and violent sub-national groups need not acquire the massive infrastructure that the Aum had assembled. Only small quantities of precursors, available on the open market, are needed to manufacture deadly chemical or biological weapons for terrorist acts. Extremist groups worldwide are increasingly learning how to manufacture chemical and biological agents, and the potential for additional chemical and biological attacks by such groups continues to grow.

The Threat of Nuclear Diversion

The Intelligence Community is taking all possible measures to aggressively support US Government efforts to ensure the security of nuclear materials and technologies. Let me first review why we are concerned about the security of nuclear materials. Russia and the other states of the former Soviet Union are not the only potential sources of nuclear weapons or materials. The reported theft of approximately 130 barrels of enriched uranium waste from a storage facility in South Africa, which was covered in the press in August 1994, demonstrates that this problem can begin in any state where there are nuclear materials, reactors, or fuel cycle facilities. A few countries whose interests are inimical to the US are attempting to acquire nuclear weapons--Iraq and Iran being two or our greatest concerns. Should one of these countries, or a terrorist group, acquire one or more nuclear weapons, they could enormously complicate US political or military activity, threaten or attack deployed US or allied forces, or possibly conduct an attack against the US. Years ago there were two impediments to would-be proliferators: the technical know-how for building a bomb and the acquisition of the fissile material. Fissile material is the highly enriched uranium or plutonium atoms that split apart in a chain reaction and create the energy

of an atomic bomb. Today the major impediment to a nation committed to acquiring a nuclear capability is the acquisition of fissile material. While it is by no means easy to make a nuclear weapons, knowledge of weapons design is sufficiently widespread that trying to maintain a shroud of secrecy around this technical knowledge no longer offers adequate protection. The protection of fissile material in the former Soviet Union has thus become even more critical at the same time that it has become more difficult. Many of the institutional mechanisms that once curtailed the spread of nuclear materials, technology, and knowledge no longer exist or are present only in a weakened capacity and effective new methods of control have yet to be fully implemented for a large portions of the world's nuclear related materials, technology, and information. At the same time, there is concern that terrorist groups could obtain and use, or threaten to use, nuclear materials. Nuclear materials are divided into two categories: 1) fissile materials, such as plutonium-239 or uranium-235, and 2) other radioactive materials, such as uranium-238, cesium-137, or cobalt-60. We, of course, track possible diversions of plutonium and uranium. But we also are concerned that non-fissile, radioactive materials could be used in a terrorist device designed to create psychological or economic trauma or to contaminate buildings, water supplies or localized areas. The list of potential proliferators is not limited to states with nuclear weapons ambitions. There are many non-state actors, such as separatists and terrorist groups, criminal organizations, and individual thieves who could choose to further their cause by using fissile or non-fissile (but radioactive) nuclear materials. Despite press articles claiming numerous instances of nuclear trafficking worldwide, we have no evidence that any fissile materials have been acquired by terrorist organizations. We also have no indications of state sponsored attempts to arm terrorist organizations with nuclear material--fissile or non-fissile. Unfortunately, this does not preclude the possibility that a terrorist group could acquire enough nuclear material, potentially through illicit trades, to conduct an operation, especially one specifically designed to incite panic. A non-state actor does not necessarily need fissile material--which is more difficult to acquire--for its purposes. Depending upon the group's objectives, any radioactive material could suffice, but the use of non-fissile materials would likely result in very little physical damage with low levels of contamination. But non-fissile radioactive materials dispersed by a conventional explosive or even released accidentally could cause damage to property and the environment, and cause social, political, and economic disruption. Examples of non-fissionable, radioactive materials seen in press reports are cesium-137, strontium-90, and cobalt-60. These cannot be used in nuclear weapons but could be used to contaminate water supplies, business centers, government facilities, or transportation networks. Although it is unlikely they would cause significant numbers of casualties, they could cause physical disruption, interruption of economic activity, post-incident clean-up, and psychological trauma to a work force and populace. Non-state actors already have attempted to use radioactive materials in recent operations. For example:

•In November 1995, a Chechen insurgent leader threatened to turn Moscow into an eternal desert with radioactive waste, according to press reports. The Chechens directed a Russian news agency to a small amount of cesium-137 in a shielded

container in a Moscow park which the Chechens claimed to have placed. Government spokesmen told the press that the material was not a threat, and would have to have been dispersed by explosives to be dangerous. According to Department of Defense assessments, there was only a very small quantity of cesium-137 in the container. If it had been dispersed with a bomb, an area of the park could have been contaminated with low levels of radiation. This could have caused disruption to the populace, but would have posed a minimal health hazard for anyone outside the immediate blast area.

•The Japanese cult Aum Shinrikyo, which attacked Japanese civilians with deadly gas just one year ago (March 20, 1995) also tried to mine its own uranium in Australia and to buy Russian nuclear warheads.

Traditional terrorist groups with established sponsors probably will remain hesitant to use a nuclear weapon, for fear of provoking a worldwide crackdown and alienating their supporters. In contrast, a new breed of multinational terrorists, exemplified by the Islamic extremists involved in the bombing of the World Trade Center, might be more likely to consider such a weapon if it were available. These groups are part of a loose association of politically committed, mixed nationality Islamic militants, apparently motivated by revenge, religious fervor, and a general hatred for the West.

The Growing Chemical and Biological Weapons Threat

The danger that a terrorist organization like the Aum Shinrikyo could again acquire the capability to launch an attack using chemical or biological weapons continues to grow. Since the November 1995 hearing on the worldwide chemical and biological weapons threat before the Permanent Subcommittee on Investigations of the Senate Committee on Government Affairs, the Intelligence Community has been engaged in continuing dialogue with Senator Nunn regarding the Aum Shinrikyo and information the Senator's staff collected. We continue to assess and analyze the threat of a terrorist chemical or biological weapons attack, a threat that remains ever present. The Aum Shinrikyo attacks in June 1994, in Matsumoto, Japan, which killed seven and injured 500, and on the subway in Tokyo in March 1995, which killed 12 and injured 5,500, were the first instances of large-scale terrorist use of chemical agents, but a variety of incidents and reports over the last two years indicate a growing terrorist interest in these weapons. These incidents include, but are not limited to:

•In February 1996, German police confiscated from a Neo-Nazi group a coded diskette that contained information on how to produce the chemical agent mustard gas. German police have stated that there are no indications yet of intent or effort to manufacture the agent.

•Tajik opposition members lacing champagne with cyanide at a New Years celebration in January 1995, killing six Russian soldiers and the wife of another, and sickening other revelers.

•Press reports of the PKK (Kurdistan Workers' Party, a guerrilla group that opposes the Turkish Government) in southeast Turkey poisoning Turkish water supplies with cyanide.

Such examples reflect an increased interest in and a capability to produce chemical and biological agents. Open source literature--including access to the Internet--provides instructions on how to make some chemical agents. Terrorist interest in chemical and biological weapons is not surprising, given the relative ease with which some of these weapons can be produced in simple laboratories, the large number of casualties they can cause, and the residual disruption of infrastructure. Although popular fiction and national attention have focused on terrorist use of nuclear weapons, chemical and biological weapons are more likely choices for such groups.

•In contrast to the fabrication of nuclear weapons, the production of biological weapons requires only a small quantity of equipment. Even very small amounts of biological and chemical weapons can cause massive casualties. The fact that only 12 Japanese died in the Tokyo subway attack de-emphasizes the significance of the 5,500 people who required treatment in hospital emergency rooms. Such a massive influx of injured--many critically--has the potential to overwhelm emergency medical facilities, even in a large metropolitan area.

•Terrorist use of these weapons also makes them weapons of mass disruption because of the necessity to decontaminate affected areas before the public will be able to begin feeling safe.

Although the Aum Shinrikyo case demonstrates that terrorists can produce CW, they also may be able to directly acquire these weapons via other means:

•Theft of agents from research labs;
•Acquisition of commercially available poisons;
•Theft of chemical munitions held by the military;
•Black market activity;
•Receipt of ready-made chemical weapons from a state sponsor.

The continued willingness of such states as Iran, Libya and Syria to support terrorism highlights the danger of state sponsorship of a terrorist's chemical or biological weapons program. Although we have no evidence of state sponsors providing chemical or biological weapons or the technologies to produce them to terrorist groups, recent revelations about Iraq's well hidden chemical and biological programs highlight the difficulty in detecting national programs to develop such weapons and disperse them to terrorist entities.

The Aum Shinrikyo

The investigation of Aum leader Shoko Asahara has resulted in a number of revelations about the cult's activities. Press reports allege that:

•Asahara ordered the capability to produce sarin beginning in 1993; a large agent production complex was not operational until March 1994.
•Some evidence suggests that the group may have tested sarin on sheep in Australia. Press reports claim that examination of some 30 sheep carcasses at an abandoned Aum site in Australia revealed the presence of sarin and other pesticides of similar structures.
•Aum planned to produce enough agent to annihilate a large Japanese city by spraying it from a helicopter. Aum possessed a Russian helicopter and two drone airplanes that, with modifications, could have been capable of delivering chemical and biological weapons. A high-ranking Aum member reportedly obtained a helicopter pilot's license in the US. Press reports also allege that Aum was considering chemical attacks using remote-controlled aircraft.
•After the breakup of the Soviet Union, Aum expanded its activities in Russia, claiming some 30,000 followers there in addition to the 10,000 in Japan.
•Aum's Russian element broadcast religious radio programs into Japan from the Russian Far East.
•Video news footage indicates that a Russian-made GSP-11 toxic gas detector was found at the Aum compound in Japan. Designed to be used on the battlefield, the Russian detector can also be used in a nerve agent production/handling facility.
•Asahara intended the simultaneous chemical strike on 10 locations in the Tokyo subway to be a massive mystery attack that would divert attention from the cult.
•In February 1996, The Thai police were informed by the Japanese embassy that members of Aum Shinrikyo had arrived in Thailand possibly to carry out terrorist activities. One individual was arrested and later identified as an Aum member; however, there is no information indicating that terrorist activity was planned or conducted in Thailand.

Iraq: A Country Study

This country study examines the magnitude of Iraq's chemical and biological warfare programs and underscores the complexity faced by international efforts to curb the spread of these weapons. Details about the breadth of Iraq's chemical and biological warfare programs are presented to demonstrate the broad range of weapons that a state sponsor of terrorism has available and could provide to terrorists if it so chooses. The unprecedented inspections conducted in Iraq by the UN have revealed much about Iraqi WMD programs. In the wake of the August 1995 defection of two high-level Iraqis, the Baghdad government turned over to the United Nations Special Commission (UNSCOM) and the International Atomic Energy Agency (IAEA) a large cache of WMD-related documents and have revealed even more information in extensive discussions with both UN organizations. The sudden revelation of new

information underscored the long-standing judgment that the Iraqis had made efforts to deceive UNSCOM and the IAEA. Such behavior resulted in UNSCOM Chairman Ekeus's delivery of a strongly worded report to the UN Security Council that was critical of Iraq's progress in fulfilling its obligations under the UN Resolutions imposed following the Gulf War. Despite the UN resolutions, Iraq successfully concealed developments in both its chemical and biological warfare programs.

Iraq's Chemical Warfare Program

These revelations demonstrated the ability of countries to hide capabilities in the face of intrusive international inspection regimes and included:

•The Iraqi program to develop the nerve agent VX actually began as early as May 1985 and continued until December 1990 without interruption; Iraq claimed previously that its program spanned only the period April 1987 to September 1988.
•Iraq produced 65 tons of chlorine, intended for the production of VX, and had more than 200 tons each of the precursor chemicals phosphorous pentasulfide and diisopropylamine. Together, these three precursors would have been sufficient to produce almost 500 tons of VX.
•Iraq developed a true binary sarin-filled artillery shell, 122-mm rockets, and aerial bombs in quantities beyond prototype level. An Al Husayn missile with a chemical warhead was flight-tested in April 1990.
•Iraq received significant assistance from outside suppliers.

Iraq's Biological Warfare Program

Following the August 1995 defections, Iraq revealed substantial information about its extensive biological warfare program. The Iraqi.Government adopted a policy to acquire biological weapons in 1974. Research and development began in 1975, but went into hiatus in 1978. In 1985, Iraq restarted biological weapons research and development. Initial work focused on literature studies, until bacterial strains were received from overseas in April 1986. Additionally, Iraq's revelations to the UN included the following information on the production and weaponization of its biological agents:
•A total of 6,000 liters of concentrated botulinum toxin and 8,425 liters of anthrax were produced at Al Hakam during 1990. An additional 5,400 liters of concentrated botulinum toxin were produced at the Daura Foot and Mouth Disease Institute during the period November 1990 to January 15, 1991; 400 liters of concentrated botulinum toxin was produced at Taji; and 150 liters of concentrated anthrax were produced at Salman Pak.
•Production of clostridium perfringens (a biological agent that causes gas gangrene and, when aerosolized, can cause severe gastric effects) began in August 1990. A total of 340 liters of concentrated agent was produced.
•Static field trials of anthrax simulant and botulinum toxin were conducted using aerial bombs as early as March 1988. Effects were observed on test animals. Additional

weaponization tests took place in November 1989, with 122-mm rockets. Live firings of 122-mm rockets filled with agents were conducted in May 1990.
•Large-scale weaponization of BW agents began in December 1990. Iraq filled more than 150 bombs and 50 warheads with agent. All these weapons were dispersed to forward storage locations.
•Iraq worked to adapt a modified aircraft drop tank for biological agent spray operations beginning in December 1990. The tank could be attached either to a piloted fighter or to an unmanned aircraft that would be guided to the target by a piloted aircraft. The tank was designed to spray up to 2,000 liters of anthrax on a target. Iraq claims the test was a failure, but three additional drop tanks were modified and stored, ready for use.

Efforts to Control Weapons Proliferation

International regimes continue to be expanded to slow the proliferation of WMD. Since the 1960s, when the US sponsored the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), this country has recognized that proliferation is a global problem and that combating it requires high levels of international cooperation. The United States has, at times, exerted unilateral influence, successfully in several cases, to discourage proliferation, but remains committed to supporting multilateral efforts to stem proliferation. To that end, the US successfully pursued the permanent extension of the NPT to prevent the spread of nuclear technologies to countries and entities attempting to acquire such weapons. With regard to the former Soviet Union, the Russians have accepted US assistance in upgrading equipment, training, and procedures, in order to address deficiencies in their security programs. Joint US-Russian cooperation on improving material protection, control, and accountability (MPC&A) has been ongoing since the signing of an agreement between MINATOM--the Russian Ministry of Atomic Energy--and the US Department of Defense in September 1992. The Intelligence Community has monitored the safety and security practices at Russian non-Ministry of Defense fissile materials facilities for some time. A comprehensive examination revealed that none of these facilities in Russia or other newly independent states had adequate safeguards or security measures by international standards for weapons-useable materials. The Intelligence Community has assisted the policy community in identifying the most critical Russian civilian sites handling weapons-useable material that could benefit from US efforts. This provided a starting point for US and Russian agreement on which facilities to concentrate initial MPC&A improvement efforts. This cooperation has been steadily expanding and currently involves over a dozen MINATOM facilities and a comparable number of facilities outside of Russia.

The US also has played a significant role in Kazakstan. After several months of sensitive negotiations, the United States purchased from Kazakstan and brought to the US Department of Energy's facility at Oak Ridge, Tennessee, for storage, 600 kilograms of highly enriched uranium. As a result, that material is unavailable to nuclear traffickers and proliferation states. Chemical and biological weapons regimes represent additional elements in the strategy to limit WMD. These efforts include:

•The Australia Group (AG) -- Formed in 1984 as a result of the use of chemical weapons in the Iran-Iraq war, the AG is an informal forum of states whose goal is to discourage and impede proliferation by harmonizing national export controls on CW precursor chemicals and manufacturing equipment, sharing information on target countries, and seeking other ways to curb the use of chemical weapons. It has since been expanded to include biological weapons.
•The Chemical Weapons Convention (CWC) -- Opened for signature in 1993 and subsequently signed by 160 countries, the CWC bans the use, development, production and storage of chemical warfare agents and munitions and requires the destruction of all existing stocks and facilities for their production. The CWC will enter into force 180 days after the 65th country deposits instruments of ratification (to date 47 countries have ratified the CWC). International negotiations the bring the CWC into force are under way.
•The Biological Weapons Convention (BWC) -- Ratified by 137 countries, the BWC prohibits the development, production, stockpiling or transfer of biological agents and weapons and mandates the destruction of all existing stocks.

While these international nonproliferation efforts were not designed to prevent terrorism, they do include nonproliferation provisions that will enhance our efforts to fight attempts by rogue states and by terrorists to acquire, to transfer, and to use chemical weapons and their precursors. For example, the CWC will require States Parties to cease transfers of certain CW agents and CW precursor chemicals to non-States Parties and to restrict such transfers to other parties. Additionally, at a BWC Special Conference held in Geneva in September 1994, the US, in order to help deter violations of and enhance compliance with the BWC, promoted the development of a legally binding instrument that increased transparency of activities and facilities that could have biological weapons applications.

Though they include provisions that should aid in preventing the acquisition of WMD by terrorist entities, treaties such as the NPT, CWC and BWC will likely be of limited effectiveness in halting the acquisition of WMD technologies by groups determined to possess them. Even if the CWC had been in effect at the time Aum Shinrikyo began its CW program, Aum was purchasing only Schedule 3 chemicals--including phosphorous trichloride--which it claimed were for the production of chemical pesticides for use on its agricultural holdings. In addition, the Aum was in the process of establishing its own university and would have been able to purchase laboratory stocks of the same chemicals in Japan without attracting attention. An effective program to combat terrorist use of WMD will require vigorous efforts by police and intelligence agencies, from local police through international law enforcement and intelligence organizations, to detect and intercept possible terrorist attacks.

Intelligence Community Response

The mission of the US Intelligence Community in the counterproliferation arena is to support those who make and execute all four aspects of US counterproliferation policy: preventing acquisition; capping or rolling back existing programs; deterring use of WMD; and ensuring US forces' ability to operate against proliferated weapons. To achieve these ends, the Intelligence Community focuses its efforts on providing accurate, comprehensive, timely, and actionable foreign intelligence. The Community has also searched for new ways and opportunities to add substantial value to counterproliferation policy decisions and activities. This has included:

•Support to those policy makers responsible for implementation of the Treaty on the Non-Proliferation of Nuclear Weapons wherein the US and other signatories have expressed their nonproliferation commitments;

•Support to those implementing the Comprehensive Test Ban Treaty, wherein the US and other signatories have expressed their commitments to end nuclear testing; and

•Examining the entire Russian nuclear weapons cycle to identify areas where transparency measures would be most effective.

•Maintaining a surge capability to quickly deploy specialists outside the United States to the scene of a terrorist nuclear or radiological threat to provide the US Mission and host government advice and guidance on dealing with the threat. During such an event, the specialists would coordinate fully with appropriate United States Government Agencies, keeping them informed and drawing upon their expertise if follow-up action is required.

Strategic Planning Process

US Intelligence has instituted a corporate strategic planning and evaluation process for support to counter proliferation. This process contributes to the Intelligence Community's National Needs Process and the National Foreign Intelligence Program (NFIP), the Joint Military Intelligence Program (JMIP), and the Tactical Intelligence and Related Activities (TIARA) program and Planning Guidance. A major benefit of this effort has been the establishment of a significant Department of Defense (DoD) representation within the DCI's Nonproliferation Center. This has helped integrate Intelligence support to DoD counterproliferation needs and actions. The Intelligence Community also has expanded its relations with the law enforcement community and is sharing information and resources in support of the law enforcement community's counterproliferation efforts. The Presidential Decision Directive (PDD) on Nonproliferation and Export Controls, related PDDs, Congressional Language, reports from government committees engaged in counterproliferation, and policy statements of several government agencies have shaped the Intelligence Community's counterproliferation strategic planning process and have helped determine a list of priority customer information requirements. These requirements are addressed in various Intelligence Community action programs such as the Annual Strategic Intelligence Review, the WMD Integrated Collection Strategy, the Countering WMD Strategic Plan, and the NSC-directed country studies. As the threat of proliferation has

increased, US Intelligence capabilities to support counterproliferation efforts have been redirected or expanded and now include:

•Assessing the intentions and plans of proliferating nations;
•Identifying nuclear weapons programs and clandestine transfer networks set up to obtain controlled materials or launder money;
•Supporting diplomatic, law enforcement, and military efforts to counter proliferation;
•Providing direct support for multilateral initiatives and security regimes; and
•Overcoming denial and deception practices set up by proliferators to conceal their programs.

US Intelligence has taken or participated in actions to address the overall challenges facing US counterproliferation efforts, including:

•Formation of the Nonproliferation and Arms Control Technology Working Group (NPAC/TWG) to enhance the coordination of R&D efforts among intelligence,operational, policy and other elements of the US Government;
•Work on the DCI-commissioned Technical Intelligence Collection Review (TICR) to identify future shortfalls in sensors against WMD and related delivery systems activities. This review addresses the 1994 Nonproliferation Review Committee identification of technical and operational needs to increase warning times before foreign targets achieve actual operational WMD capability;
•Identifying funding to maintain Technical Intelligence Collection Programs related to WMD and delivery system tests of proliferating nations;
•Fostering the development of new technologies with the potential to improve our ability to detect WMD activities at significantly longer ranges than possible today. For example, the Central Intelligence Agency has explored the efficacy of high risk, high payoff counterproliferation-related Research and Development initiatives;
•Establishing a relationship to enhance cooperation between CIA and R&D components;
•Redirecting and reorganizing intelligence activities to increase and sharpen the focus of counterproliferation-related efforts--both analytically and operationally; and
•Redirecting resources and activities toward assisting Federal Bureau of Investigation and US Customs Service efforts to identify, target, and apprehend individuals engaged in the trafficking and smuggling of nuclear materials worldwide.

Additionally, the creation of JMIP to coordinate joint, DoD-wide initiatives, activities and programs, will provide intelligence information and support to multiple DoD customers and should significantly enhance US Intelligence support to DoD's counterproliferation program.

Intelligence Success to Date

US efforts to counter the proliferation of weapons of mass destruction have enjoyed some successes over the past several years. Director Deutch observed last week, I

think a tremendous amount of progress has been done...to build a serious, post-Cold War, nonproliferation intelligence capability. For obvious reasons, we cannot describe in this forum many of our successes. Some that we can include:

•Supporting Department of State efforts to provide actionable intelligence to the UN Special Commission (UNSCOM) inspection and monitoring effort in Iraq.
•Developing a list of collection indicators to alert collectors and analysts prior to use of chemical and biological weapons. Similar initiatives are also underway to provide early warning for the possible diversion of nuclear materials.
•Establishing a southern Tier Study Group designed to focus on all WMD-related proliferation issues in the southern tier of the Former Soviet Union.
•Providing Congressional Committees with a report that reviewed and evaluated nonproliferation programs in the NFIP fiscal year 1996 budget submission.

But even if we could list all of our accomplishments, we would be the first to say there is more to do. Over the next year, the Community will seek to:

•Strengthen and focus our integrated collection strategy;
•Work to enhance the Community's information processing capabilities;
•Implement unified and standardized information systems, to include shared access by intelligence and consumer organizations;
•Strengthen and broaden foreign language training and support tools;
•continue to review and evaluate new methodologies and technologies;
•And, as part of the DCI and Secretary of Defense joint program and budget reviews, continue to evaluate intelligence resources and capabilities for optimal support for actions to counter proliferation.

In closing, I would note that intelligence is essential to countering the proliferation and potential use of weapons of mass destruction. The recent anniversary of the poison gas attack in the Tokyo subway reminded all of the devastating consequences of such an attack. The US is not invulnerable. While we will continue to provide intelligence support to those who would have to respond to such an event, we must do all that we can to eliminate or at least minimize such a possibility. Of course we will continue efforts to impede and prevent the spread and acquisition of such weapons and technology. That, however, is not enough. Efforts to terminate developmental program and to deter weapons use must be enhanced.

Appendix A: Chronology of Nuclear Smuggling Incidents

Date of Event

---------- 1996 ----------

17 March Tanzanian police arrested one individual last week and seized a container of radioactive cesium.

9 March Romanian police announced on 8 March that they are holding two individuals for attempting to sell stolen radioactive material, according to press reports. A police spokesman announced that two had in their possession 82 kg of radioactive material including low enriched uranium. Officials also found reportedly secret documents stolen from the Research and Design Center for Radioactive Metals.

4 March UPDATE (12 February): According to press reports, Lithuanian officials have determined that the 100 kg of radioactive material seized last month from an armed gang is uranium-238. This material was stolen from a company responsible for maintenance at the nearby Ignalina nuclear power plant.

23 February According to press reports, the Belarus Committee for State Security (KGB) seized five kilograms of cesium-133. The radioactive metal reportedly was sealed in glass containers. Belarus authorities are investigating the incident, according to press.

12 February Lithuanian authorities announced that they had arrested seven people and seized nearly 100 kg of radioactive material, according to press reports. The material, believed to be uranium, will undergo further tests to ascertain its makeup and origin. It was emitting 14,000 microroentgens per hour. Some reports stated that the material was a component of a nuclear fuel assembly which has been missing from the n early Ignalina nuclear power plant for several years. The Ignalina plant manager claims that the seized material is not nuclear fuel or equipment used at his facility.

1 February Swiss federal prosecutors announced on 1 February the arrest of a Swiss citizen of Turkish descent for attempting to sell a sample of "slightly-enriched" uranium in Switzerland, according to press. Swiss authorities stated that the individual claimed the sample was part of a larger cache still in Turkey. Turkish police using information from their Swiss counterparts, then arrested eight people and seized 1.128 kg of similar material. Press reports indicate that the uranium was similar to that used in nuclear power plant fuel rods. Swiss authorities reportedly are conducting tests to determine the uranium's country of origin.

25 January According to press reports, German authorities have charged a merchant and his lawyer with crimes stemming from their attempt to sell radioactive cesium to

another merchant who was a police informant. The cesium reportedly was transported to Germany from Zaire on board a commercial airliner.

21 January UPDATE (7 November 95): The German parliamentary commission investigating the 1994 plutonium smuggling incident, reportedly has uncovered German government documents indicating that the three smugglers offered to supply 11 kilograms of Russian-origin, weapons-grade plutonium, which they claimed was enough to build three nuclear weapons, according to press reports.

18 January According to press reports, German authorities have charged a merchant and his lawyer with crimes stemming from their attempt to sell radioactive cesium-137 smuggled from Zaire to another merchant who was a police informant. The cesium reportedly was transported to Germany from Zaire on board a commercial airliner.

17 January A Palestinian in Dubai, UAE has offered to sell three kilograms of reportedly Russian-origin red mercury to a Lebanese-American businessman, according to US diplomatic reporting.

--------- 1995 ----------

28 December According to press reports, the Russian Federal Security Service (FSB) arrested nine members of a criminal organization in Novosibirsk and seized a quantity of radioactive material. The material was identified in press reports as "enriched" uranium-235. The material had been transported to Novosibirsk by middlemen, possibly from Kazakstan. The ultimate destination may have been South Korea, according to press reports.

2 December UPDATE (9 Nov 95): According to Italian press reports, Italian prosecutors have arrested an individual, Roger D'Onofrio, with reported links to the U S Central Intelligence Agency (CIA) and the Italian-American mafia as part of their investigation of smuggling radioactive materials, money-laundering and arms trafficking. D'Onofrio, 72, reportedly has dual Italian and U.S. citizenship and retired from t he CIA only two years ago. The ring he is alleged to have been part of is said to have been active from the early 1990s up to this year. Italian investigators reportedly suspect that D'Onofrio is the mastermind behind an international ring which laundered dirty money and smuggled gold, weapons, and radioactive material. His name also appears in another investigation into an arms smuggling operation between Italy and the Middle East, according to press reports. D'Onofrio was taken into preventive custody on charges of money laundering and acting as a broker in illegal currency dealing. According to press, the prosecutors had so far ascertained money laundering for over 2.5 billion dollars on behalf of secret service and organized crime sources in complicity with diplomats, the ruling families in Kuwait, Morocco and Zambia, bankers, prelates and others.

1 December UPDATE (23 November): According to US diplomats in Moscow, the

Russian Federal Security Service (FSB) delivered an official statement to US official s regarding the radioactive material discovered in Izmailov park on 23 November. The container, which held cesium-137, posed no public health threat. Radiation levels of the cesium were between 10 to more than 50 millicurrie. The radioactive material may have been used as an instrument calibration source used in flaw detection equipment. 30 November A former Greenpeace president revealed that the organization had been offered a nuclear warhead by a disgruntled former Soviet officer keen to highlight lax security, according to press accounts. The former Greenpeace official stated in a recently published book that a Soviet officer with access to nuclear weapons offered Greenpeace an 800 kg nuclear Scud warhead for public display in Berlin. The offer was made shortly before 7 September 1991.

29 November Russian security officials have recovered four containers with radioactive cesium, stolen from an industrial plant in the Urals and arrested the thieves, according to press reports. Federal Security Service (FSB) officers found the 90-kilogram (198-pound) containers in a shaft of an old mine, the ITAR-Tass news agency reported. One of the alleged thieves, the Bakal mining plant's electrical engineer, had initially kept them at his vegetable garden but moved them to a safer place after the theft had been discovered, claimed security officials. Two officials of a local penitentiary were his accomplices, they further alleged. Each container held a capsule with cesium 137, a radioactive isotope used in geological research, as well as in medicine. The containers were similar to the one allegedly planted by Chechen rebels in a Moscow park.

23 November Acting on a tip from Chechen separatist leader Basayev, Russian television reporters discovered a 32 kg container--reportedly holding cesium-137--in a Moscow park. The container was reportedly removed and turned over to the Russian Federal Security Service (FSB). FSB officials stated that an official investigation was underway and that no further comments would be made until the inquiry was completed, according to press reports. Television reports quote a highly-placed FSB officer as stating unofficially that the object was a piece of a hospital x-ray machine. Basayev claimed earlier this month that several containers of radioactive material attached to explosive devices had been planted in Russia. In a television interview aired on 15 October, Russian Interior minister Kulikov stated that Chechen separatist leader Basayev might have radioactive waste or radioisotopes taken from the Budyonnovsk hospital seized by Chechen rebels last spring.

23 November UPDATE (7 Nov 95): A German court sentenced Adolph Jaekle, a German businessman, to 51/2 years in prison for smuggling weapons grade plutonium into the country, according to press reports. Investigators made the first in a series of contraband plutonium seizures in Germany when they raided Jaekle's home, in the southern town of Tengen in May, 1994, and found a lead cylinder containing 6.15 grams of plutonium 239. Jaekle had pleaded not guilty to the plutonium charge, arguing that he did not know what the substance was.

11 November Russian Federal Security Service (FSB) officials arrested two Lithuanian citizens in Smolensk for smuggling 10 kgs of "uranium-238" into Russia, according to Russian television reports. Three Russians also were arrested for attempting to sell the uranium. Both the Lithuanians and the Russians claimed that poverty had induced them to attempt to traffic in smuggled nuclear materials. According to press accounts, Russian authorities stressed that the material was not weapons grade and had no commercial or industrial uses.

9 November Italian prosecutors reportedly have asked Spanish authorities for permission to question the Archbishop of Barcelona about his role in an international criminal syndicate involved in smuggling radioactive materials, according to Italian press accounts. Accusations against the Archbishop arose after Italian officials tapped a telephone conversation in which the Archbishop was named as playing a leading role in the criminal enterprise. Both the Archbishop and the Vatican have vehemently denied the accusations. The Spanish Justice ministry has characterized the Italian request as "not very well thought out." The Italian investigation grew out on an earlier probe into money laundering operations which reportedly uncovered information that a criminal enterprise involving a self-professed Italian intelligence official, was attempting to sell 7.5 kg osmium for $63,000 per gram, according to Italian press accounts.

7 November During a search of a car at the Polish-Czech border, Polish Border Guards discovered 11 cigarette pack-size containers filled with strontium-90, according to press accounts. This incident is the first case in 1995 involving smuggling radioactive material through Poland.

7 November UPDATE (10 Aug 94): Adolf Jaekle, accused of smuggling Russian-origin plutonium following a May 1994 raid on his home, denied any involvement in nuclear smuggling, according to press reports. Jaekle insisted that the container of plutonium was planted at his home and that the container was not the same one he took from a Swiss associate for metal reprocessing.

7 November Iranian press reports indicate the Iranian law enforcement authorities have arrested five Iranians and seized nine packets of uranium in Tehran and two other cities. No details were released regarding amount of material or whether it was enriched or not.

25 October The cleaning staff at Moscow's Sheremetyevo 2 airport found a small lead container packed with radioactive substances in the men's restrooms, according to press reports. Experts reportedly are attempting to determine the exact composition of the three sources of ionizing radiation found in the container. The speculation, in the Russian press, was that a nuclear smuggler lost his nerve and abandoned the material during an aborted smuggling attempt.

19 October UPDATE (10 Aug 94): According to a 19 October article in Der Stern,

nuclear weapons smugglers involved in smuggling Russian-origin plutonium into Germany in August 1994 have stored eight to ten kilograms of weapons-grade plutonium in Berlin. The article also implicates highly placed Russians in the smuggling activity.

14 October Russian mafia figures reportedly were behind the 1993 theft of radioactive beryllium from a Russian nuclear laboratory and the failed attempt to sell the material in the West, according to press reports. The theft, which was widely reported in 1993, was seized by police in Lithuania and remains today in the bank vault where it was first discovered. According to press, the smugglers were preparing to sell the beryllium to an Austrian middleman who in turn had a mystery buyer who reportedly was willing to pay as much as $24 million for the material. The buyer, although never identified, was said to be Korean. Beryllium, which is used in missile guidance systems, is a highly efficient neutron reflector, according to public statements by nuclear scientists.

10 October Russian authorities claim that there have been no identified incidents in which weapons-grade radioactive material has been smuggled out of Russia, according to press reports. In a press conference, Russian General Terekhov of the Interior Ministry, stated that of the 16 cases involving theft of radioactive materials, none could have been used to make nuclear weapons. He also ruled out any involvement by Russian organized criminal organizations in the thefts. The general claimed that the thefts were spontaneous actions by individuals working at nuclear facilities. The Russian officials concluded the press conference by stating that there is no black market in nuclear materials.

1 September According to press reports, Bulgarian police had broken an international nuclear smuggling ring composed of Russians and Ukrainians. Police spokesmen, declining to disclose details only said that the materials seized were of strategic value and included rare metals. The arrests were the culmination of a year-long undercover operation. Senior police officials commented that they were still investigating the final destination of the materials, some of which were radioactive.

15 June Press reports indicate that so far in 1995 Romanian authorities have seized 24 kgs of uranium powder and tablets and 1994 they arrested 24 people for involvement in nuclear smuggling and seized 10.35 kgs of uranium powder and tablets. From 1989 to 1993, the Romanians reportedly broke up five gangs, arrested 50 people, and seized 230 kgs of nuclear material.

13 April Slovak police culminated a long investigation with the discovery of 18.39 kg of nuclear material, 17.5 kg of which apparently is U-238, in a car stopped near Poprad in eastern Slovakia. Altogether, three Hungarians, four Slovaks, and two Ukrainians were arrested. This gang was connected to three other nuclear material smuggling incidents.

5 April Four brass containers weighing 2 kilos each containing radioactive americium-

241 and cesium-137 were stolen from a storeroom of isotopes in Wroclaw, Poland.
4 April Press reports that 6 kg of U-235, U-238, radium, and palladium were found in a Kiev apartment. Occupants were ex-army, a lieutenant colonel and a warrant officer, and material reportedly came from Russia.
2 April Documents recovered by Japanese police in the investigation of Aum Shinrikyo involvement in the Tokyo subway sarin gas attack reportedly indicated that the terrorists were collecting information on uranium enrichment and laser beam technologies. A spokesman for Russia's prestigious nuclear physics laboratory, Kurchatov Institute, acknowledged that at least one Aum Shinrikyo follower was working at the institute.

14 March Polish police in Bielska-Biala province arrested a man for possession of uranium.

8 March Italian police arrested one Nicola Todesco for murder in a plutonium smuggling case gone awry when the murder victim did not have the money to pay for a quantity of plutonium smuggled out of Bulgaria. Todesco claimed he threw 5g of plutonium into the Adige river, but no trace of it was found after an extensive search. (Comment:Although an official Italian spokesman believed the plutonium was "enriched for military use," it had not been analyzed and may be another scam involving 'plutonium screws' from smoke detectors.

25 January According to Talinn news broadcasts, Lithuanian border police, using U.S.-supplied stationary radiation detectors, seized two tons of radioactive wolfram hidden in a secret compartment in a truck trailer. (The "wolfram" is tungsten, which has a short half-life, and probably was "infected" by a radioactive contaminant.) The incident occurred at the Lithuanian-Belorus border, and the truck' s owner and two other men were arrested. A similar incident occurred a week earlier at another border post but no details are available.

---------- 1994 ----------

14 December Czech police seized 2.72 kg of material--later identified as 87.7 percent enriched U-235--in Prague; this is the largest recorded seizure of such material. Police arrested a Czech nuclear physicist and two citizens of the Former Soviet Union. The uranium apparently came from the FSU and was to be smuggled to Western Europe.

10 December Press reporting indicates Hungarian border guards seized 1.7 kg of uranium and arrested four Slovak citizens. The material (depleted uranium and reactor fuel grade) reportedly was concealed in a fruit jar and was to be smuggled into Austria.

6 December In a long article in Pravda, it was reported that three staffers of the Institute of Nuclear Physics were convicted of stealing 4.5 kg of uranium.

10 November Press reporting indicates Hungarian police discovered 26 kg of

radioactive material in the trunk of a car. Three suspects were subsequently arrested. November Press reporting indicates German police seized 1 milligram of cesium-137 in early November and arrested two suspects.

19 October Press reporting indicates Turkish police arrested an Azeri national trying to sell 750 g of uranium.

17 October Press reporting indicates Russian authorities seized 27 kg of U-238, an unknown quantity of U-235 and detained 12 members of a criminal gang. October Press reporting indicates that in mid-October, four Indian villagers were arrested attempting to sell 2.5 kg of yellowcake, i.e. uranium extracted from ore.

13 October Press reporting indicates Bulgarian officials seized four lead capsules suspected of containing radioactive material. The capsules were found on a bus enroute to Turkey and police detained the two bus drivers.

10 October Press reporting indicates Romanian authorities arrested seven people and seized 7 kg of uranium and an unidentified quantity of strontium or cesium.

01 October Press reporting indicates Romanian police arrested four people trying to sell over 4 kg of U-235 and U-238.

October Press reporting dated 26 October indicates Russian authorities arrested three men trying to pass 67 kg of U-238 to unidentified individuals in the city of Pskov.

28 September Press reporting indicates that a container with radioactive substances was found on a street in Tallinn.

28 September Romanian authorities arrested several individuals who were attempting to sell 4.55 kg of uranium tetrachloride (61.9 percent uranium) for $25 thousand per kg, according to press reports

28 September Press reporting indicates Slovak officials arrested four Slovaks trying to smuggle almost 1 kg of U-235 (judged not to be weapons-grade) into Hungary.

26 September Press reporting indicates the discovery of a glass flask containing unspecified "weak radioactive material" at the Wetzlar railroad station in Germany.

September A Pole tried to sell 1 kg of U-235/238 in Germany. A German court subsequently sentenced him to two and a half years in prison for trading in radioactive uranium.

11 September Press reports indicate German police arrested a Zairian national attempting to smuggle 850 g of uraninite into Germany.

07 September Press reports indicate Russian police arrested three people in Glazov trying to sell 100 kg of U-238.

05 September Press reports indicate Bulgarian authorities arrested six Bulgarians in connection and seized 19 containers of radioactive material.

30 August Press reports indicate thieves broke into a chemical plant in Tambov and stole 4.5 g of cesium 137.

29 August Press reports indicate Hungarian police arrested two men and seized 4.4 kg of material believed to be fuel rods from a reactor in Russia.

20 August Press reports Russian authorities arrested two men attempting to steal 9.5 kg of uranium 238 from the Arzamas-16 nuclear weapons research facility.

18 August Press reports indicate Estonian police arrested a man and seized 3 kg of U-238 he had buried under his garage. According to press reporting, about 100 uranium-contaminated drums were stolen from South Africa's Atomic Energy Corporation plant in Pelindaba, Transvaal.

12 August Press reports indicate that St. Petersburg police arrested three men trying to sell 60 kg of unidentified nuclear material.

12 August Press reports indicate German police in Bremen arrested a German who claimed to have 2 g of plutonium; the sample contained only minute amounts of legally obtainable plutonium.

10 August Press report indicates that over 500 g of nuclear material were seized at Munich airport. The trial began on 10 May 1995 of two men for possession of 363g (12.8 ounces) of weapons-grade plutonium-239.

August Unconfirmed press report says 3 kg of enriched uranium were seized in August in southwestern Romania.

July Press reporting dated 19 July indicates Turkish National Police arrested seven Turks and seized 12 kg of weapons-grade uranium.

July According to 6 July press reporting, Russian authorities in Shezninks discover 5.5 kg of U-238 previously stolen from the Chelyabinsk-65 nuclear facility.

July According to a 2 November press report, police in Timisoara, Romania, arrested five Romanians trying to sell 2.6 kg of Russian uranium.

13 June Press reporting indicates a seizure of 0.8 g of uranium 235 (enriched to 88%) occurred in Landshut, Germany.

June According to 6 June press reporting, Russian security official announces the arrest of three Russians in St. Petersburg who allegedly tried to sell 3.5 kg of HEU.

June According to an 8 July press report, Russian authorities arrested three officers from the Northern Fleet accused of having stolen 4.5 kg of U-238 from their base in Nov 93.
June According to a 2 November press report, police in Pitesti, Romania, arrested three Romanians trying to sell 3 kg of uranium tablets.

May According to 30 July press reporting, 56 g of material, including 6 g of plutonium 239, were seized and Adolf Jaekle, a German citizen, was arrested in Germany in May.

---------- 1993 ----------

November In a case stemming from an incident in November 1993 in which a Russian naval officer stole 4 kg of 20 percent enriched U 235 nuclear fuel rods from a poorly guarded area at Severomorsk, a Russian court found the officer guilty but gave him a suspended sentence because he admitted the act. Two accomplices were sentenced to three years at a labor camp.

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Appendix B: Chemical Agents

Chemical warfare agents are among the easiest WMD to produce. The toxicity of chemical agents falls generally between that of the more deadly biological agents and that of conventional weapons. The earliest chemical agents, first used in World War I, were far less sophisticated and far less lethal than those developed in subsequent decades. Proliferating nations have tended to first produce blister agents and, as their technologies advance, to develop the more lethal nerve agents.

Types of CW Agents

•Choking agents are the oldest CW agents. This class includes chlorine and phosgene, first used in World War I. These agents have a corrosive effect on the respiratory system that causes the lungs to fill with water and choke the victim. These agents are delivered as heavy gases that remain near ground level and tend to fill depressions. They dissipate rapidly in a breeze and are among the least effective traditional CW agents.
•Blood agents are absorbed into the body primarily by breathing; they prevent the normal utilization of oxygen by the cells and cause rapid damage to body tissues. This class includes cyanide and cyanogen chloride. They are highly volatile and in a gaseous state dissipate rapidly in air. These agents are most effective when delivered in a surprise attack.
•Blister agents are used to cause medical casualties; they affect the eyes and lungs and blister the skin. Such agents are simple to produce, and include sulfur mustard, nitrogen mustard, and lewisite. Sulfur mustard is considered by some as the ideal CW agent. It presents both a respiratory and a percutaneous (skin) hazard, forcing personnel to wear masks and protective clothing. It is persistent and presents a long-term hazard, forcing decontamination of the battlefield.
•G-series nerve agents, developed in the 1930s, cause paralysis of the respiratory musculature and subsequent death, in sufficient concentration. They include tabun, sarin, soman, and GF. These agents act rapidly and may be absorbed through the skin or the respiratory tract. Some agents, such as tabun and sarin, tend to be relatively nonpersistent, creating a short-term respiratory hazard on the battlefield.
•V-series nerve agents, developed in the 1950s, are similar to, but more advanced than, G-series agents. This class includes VE, VG, VM, VS, and VX. These agents are more toxic and more persistent than the G-agents and present a greater skin hazard. They are used for long-term contamination of territory.

Production of CW Agents

Many CW agents, particularly choking, blood, and blister agents, are relatively easy to produce. Some of their technologies are more than 80 years old, making them accessible by virtually any Third World country and many terrorist groups. Newer agents, particularly nerve agents, are somewhat more difficult to produce. However,

much of the technology to produce these agents is widely available in the public domain and, as demonstrated by the Aum Shinrikyo in Japan, these agents can be produced by a determined terrorist group. Production of CW agents is similar to that of legitimate commercial compounds. Both involve use of standard chemical process equipment. Some of the more sophisticated equipment is distinctive enough to warrant special consideration, and some of this equipment is controlled by the Australia Group. In particular, equipment that is exceptionally resistant to corrosion has important applications for CW because of the highly corrosive compounds encountered in CW agent production.

Methods of Delivery

Development of a dispersal device is somewhat more technologically complex than the production of chemical agents. Many conventional munitions, such as bombs, artillery shells, grenades, and mines, can be modified to deliver chemical agents. A spray tank, commercially available for dissemination of agricultural chemicals from aircraft, can be used to disseminate chemical agents. Similarly, ground-based aerosol generators used to disseminate pesticides can be used for CW purposes.

Chemical warfare (CW) can be considered the military use of toxic substances such that the chemical effects of these substances on exposed personnel result in incapacitation or death. It is the impact of chemical effects instead of physical effects (such as blast and heat) that distinguishes chemical weapons from conventional weapons, even though both contain chemicals. In many cases in the Third World, there can be considerable confusion as to what is a chemical weapon and what is not. Some countries consider smoke, flame, incendiary, or riot control weapons to be chemical weapons and label them as such. In addition, conventional weapons can inflict casualties resembling those caused by chemical weapons.

Appendix C: Biological Agents

Many developing countries see biological weapons--like chemical weapons--as having a twofold utility: as a "poor man's atomic bomb," intended to deter attacks from stronger, unconventionally armed neighbors; and as a relatively cheap force multiplier that can help compensate for shortcomings in conventional arsenals. Because much of the same biotechnology equipment employed by modern pharmaceutical programs or laboratories associated with modern hospitals can be used to foster a biological weapons program, identification of an offensive biological warfare program can be extremely difficult. Most equipment used in BW-related programs has legitimate applications, providing potential proliferators with the ability to conceal BW activity within legitimate research and development and industrial programs. The manufacture of vaccines for human or veterinary use can camouflage the production of large quantities of BW agents. A number of experts speculate that terrorists might acquire biological agents more easily than chemical agents. And both BW and CW would be far easier to develop than nuclear weapons.

Types of BW Agents

BW agents differ widely in infectiousness, length of incubation period, and lethality.

- Bacteria are single-cell organisms that are the causative agents of anthrax, brucellosis, tularemia, plague, and numerous other diseases. They vary considerably in infectivity and lethality.
- Rickettsiae are microorganisms that resemble bacteria in form and structure but differ in that they are intracellular parasites that can reproduce inside animal cells. Examples of rickettsial diseases that might be used for BW include typhus, Rocky Mountain spotted fever, and Q fever.
- Viruses are intracellular parasites that are about 100 times smaller than bacteria. They can infect humans, crops, or domestic animals. An example of a virus that might be used for BW is Venezuelan Equine Encephalitis. VEE virus causes a highly infectious disease that incapacitates but rarely kills. A virus's strength can be altered to increase its efficiency. A particularly powerful strain of an endemic pathogen could simply be blamed on a chance natural mutation.
- Some Fungi can cause severe disease in humans, such as coccidioidmycosis (valley fever) and histoplasmosis. Moreover, fungal diseases are devastating to plants and might be used to destroy staple crops and cause widespread hunger and economic hardship. Examples of plant fungal pathogens include rice blast, cereal rust, and potato blight.
- A toxin is a poisonous substance made by a living system, or a synthetic analogue of a naturally occurring poison. An enormous variety of toxins are manufactured by bacteria, fungi, marine organisms, plants, insects, spiders, and other animals.

Production of BW Agents

BW agents are relatively easy and inexpensive to produce for any nation that has a

modestly sophisticated pharmaceutical or fermentation industry. Mass-production methods for growing cultures are widely used in the commercial production of yogurt, yeast, beer, antibiotics, and vaccines. Almost all equipment needed for the production of pathogens and toxins is dual-use and available on the international market, increasing the potential for concealing illicit activities under the cover of legitimate production.

Methods of Delivery

BW agents are nonvolatile solids that would be disseminated either as a liquid slurry or a dry powder of freeze-dried organisms or toxin. Possible delivery systems range in complexity and effectiveness from an agricultural sprayer mounted on a truck to a specialized cluster warhead carried on a ballistic missile. The key to producing large-scale respiratory infections is to generate an aerosol or stable cloud of suspended microscopic droplets, each containing from one to thousands of bacterial or virus particles. Fogs and smokes are examples of visible aerosols.

Biological warfare (BW) can be considered the military use of living organisms or associated materials that are intended to cause disability, disease, or death in humans, animals, or crops--for hostile purposes. Agents include pathogenic micro-organisms, toxins and bioactive substances, which may be weaponized, using both military and civilian-type delivery systems.

BACKGROUNDER: TERRORISM

Prepared by the Federal Emergency Management Agency
Updated August 25, 1996

EMERGENCY INFORMATION

1. Most terrorist incidents in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas and pipe and fire bombs.

2. The effects of terrorism can vary significantly from loss of life and injuries to property damage and disruptions in services such as electricity, water supply, public transportation and communications.

3. One way governments attempt to reduce our vulnerability to terrorist incidents is by increasing security at airports and other public facilities. The U.S. government also works with other countries to limit the sources of support for terrorism.

WHAT IS TERRORISM?

Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion or ransom. Terrorists often use threats to create fear among the public, to try to convince citizens that their government is powerless to prevent terrorism, and to get immediate publicity for their causes.

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States as one of two types--domestic terrorism or international terrorism. Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries.

BIOLOGICAL AND CHEMICAL WEAPONS

Biological agents are infectious microbes or toxins used to produce illness or death in people, animals or plants. Biological agents can be dispersed as aerosols or airborne particles. Terrorists may use biological agents to contaminate food or water because they are extremely difficult to detect. Chemical agents kill or incapacitate people, destroy livestock or ravage crops. Some chemical agents are odorless and tasteless and are difficult to detect. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (several hours to several days).

Biological and chemical weapons have been used primarily to terrorize an unprotected civilian population and not as a weapon of war.

This is because of fear of retaliation and the likelihood that the agent would contaminate the battlefield for a long period of time. The Persian Gulf War in 1991 and other confrontations in the Middle East were causes for concern in the United States regarding the possibility of chemical or biological warfare. While no incidents occurred, there remains a concern that such weapons could be involved in an accident or be used by terrorists.

FACTS ABOUT TERRORISM

•On February 29, 1993, a bombing in the parking garage of the World Trade Center in New York City resulted in the deaths of five people and thousands of injuries. The bomb left a crater 200 by 100 feet wide and five stories deep. The World Trade Center is the second largest building in the world and houses 100,000 workers and visitors each day.

•The Department of Defense estimates that as many as 26 nations may possess chemical agents and/or weapons and an additional 12 may be seeking to develop them.

•In recent years the largest number of terrorist strikes have occurred in the Western States and Puerto Rico. Attacks in Puerto Rico accounted for about 60 percent of all terrorist incidents between 1983 and 1991 that occurred on United States territory.

•The Central Intelligence Agency reports that at least ten countries are believed to possess or be conducting research on biological agents for weaponization.

TERRORISM IN THE UNITED STATES

•In the United States, most terrorist incidents have involved small extremist groups who use terrorism to achieve a designated objective. Local, State and Federal law enforcement officials monitor suspected terrorist groups and try to prevent or protect against a suspected attack. Additionally, the U.S. government works with other countries to limit the sources of support for terrorism.

•A terrorist attack can take several forms, depending on the technological means available to the terrorist, the nature of the political issue motivating the attack, and the points of weakness of the terrorist's target. Bombings are the most frequently used terrorist method in the United States. Other possibilities includes an attack at transportation facilities, an attack against utilities or other public services or an incident involving chemical or biological agents.

•Terrorist incidents in this country have included bombings of the World Trade Center in New York City, the United States Capitol Building in Washington, D.C. and Mobil Oil corporate headquarters in New York City.

Chemical Warfare Agents

Source: A FOA Briefing Book on Chemical Weapons

What is a Chemical Warfare Agent?

A United Nations report from 1969 defines chemical warfare agents as " ... chemical substances, whether gaseous, liquid or solid, which might be employed because of their direct toxic effects on man, animals and plants ... ". The Chemical Weapons Convention defines chemical weapons as including not only toxic chemicals but also ammunition and equipment for their dispersal. Toxic chemicals are stated to be " ... any chemical which, through its chemical effect on living processes, may cause death, temporary loss of performance, or permanent injury to people and animals". Plants are not mentioned in this context. Toxins, i.e., poisons produced by living organisms and their synthetic equivalents, are classed as chemical warfare agents if they are used for military purposes. However, they have a special position since they are covered by the Biological and Toxin Weapons Convention of 1972. This convention bans the development, production and stockpiling of such substances not required for peaceful purposes.

Today, thousands of poisonous substances are known but only a few are considered suitable for chemical warfare. About 70 different chemicals have been used or stockpiled as CW agents during the 20th century. Today, only a few of these are considered of interest owing to a number of demands that must be placed on a substance if it is to be of use as a CW agent.

•A presumptive agent must not only be highly toxic but also "suitably highly toxic" so that it is not too difficult to handle.

•The substance must be capable of being stored for long periods in containers without degradation and without corroding the packaging material.

•It must be relatively resistant to atmospheric water and oxygen so that it does not lose effect when dispersed.

•It must also withstand the heat developed when dispersed.

"War Gases" are Seldom Gases

CW agents are frequently called war gases and a war where CW agents are used is usually called a gas war. These incorrect terms are a result of history. During the First World War use was made of chlorine and phosgene which are gases at room temperature and normal atmospheric pressure. The CW agents used today are only exceptionally gases. Normally they are liquids or solids. However, a certain amount of the substance is always in volatile form (the amount depending on how rapidly the

substance evaporates) and the gas concentration may become poisonous. Both solid substances and liquids can also be dispersed in the air in atomized form, so-called aerosols. An aerosol can penetrate the body through the respiratory organs in the same way as a gas. Some CW agents can also penetrate the skin. This mainly concerns liquids but in some cases also gases and aerosols. Solid substances penetrate the skin slowly unless they happen to be mixed with a suitable solvent.

Effects on Vegetation

Flowers and leaves of some plants may change colour if they are exposed to droplets of a CW agent in an attack. Light or matt spots may occur as well as brown discoloration, particularly on leaves. Entire trees, or parts of them, may also get brown discoloration in situations of strong exposure. The discoloration often arises within a few minutes but may also occur after some days.

Classification

CW agents can be classified in many different ways. There are, for example, volatile substances, which mainly contaminate the air, or persistent substances, which are involatile and therefore mainly cover surfaces. CW agents mainly used against people may also be divided into lethal and incapacitating cathegories. A substance is classified as incapacitating if less than 1/100 of the lethal dose causes incapacitation, e.g., through nausea or visual problems. The limit between lethal and incapacitating substances is not absolute but refers to a statistical average. In comparison, it may be mentioned that the ratio for the nerve agents between the incapacitating and lethal dose is approximately 1/10. Chemical warfare agents are generally also classifiedaccording to their effect on the organism. In order to achieve good ground coverage when dispersed from a high altitude with persistent CW agents thedispersed droplets must be sufficiently large to ensure that they fall within the target area and do not get transported elsewhere by the wind. This can be achieved by dissolving polymers (e.g., polystyrene or rubber products) in the CW agent to make the product highly-viscous or thickened. The result will be that the persistence time and adhesive ability increase which thus complicates decontamination. Although it may appear that a CW agent can be "custom-made" for a certain purpose, this is not the case. Instead, there is always some uncertainty about the persistence time, the dispersal and the effect.

These Military Chemicals are Not Considered to be Chemical Weapons

Incendiary agents such as napalm and phosphorus are not considered to be CW agents since they achieve their effect mainly through thermal energy. Certain types of smoke screen may be poisonous in extremely high concentrations but, nonetheless, smoke ammunition is not classed as a chemical weapon since the poisonous effect is

not the reason for their use. Plants, microorganisms, algae, etc. which produce toxins are not classed as chemical weapons even if the produced toxins belong to that class. Pathogenic microorganisms, mainly viruses and bacteria, are classed as biological weapons.

Main Groups

- Nerve Agents
- Mustard Agents
- Hydrogen Cyanide
- Tear Gases
- Arsines
- Psychotomimetic Agents
- Toxins
- Potential CW Agents

Nerve Agents

Lethal organo-phosphorus compounds inhibiting cholinesterase

Among lethal CW agents, the nerve agents have had an entirely dominant role since the Second World War. Nerve agents acquired their name because they affect the transmission of nerve impulses in the nervous system. All nerve agents belong chemically to the group of organo-phosphorus compounds. They are stable and easily dispersed, highly toxic and have rapid effects both when absorbed through the skin and via respiration. Nerve agents can be manufactured by means of fairly simple chemical techniques. The raw materials are inexpensive and generally readily available. It was not until the early 1930's that German chemists observed that organo-phosphorus compounds could be poisonous. In 1934, Dr Gerhard Schrader, a chemist at IG Farben, was given the task of developing a pesticide. Two years later a phosphorus compound with extremely high toxicity was produced for the first time. According to contemporary regulations, discoveries with military implications had to be reported to the military authorities, which was also done with Schrader's discovery. This phosphorus compound, given the name tabun, was the first of the substances later referred to as nerve agents. A factory for production of the new CW agent was built and a total of 12 000 tonnes of tabun were produced during the years 1942-1945. At the end of the war the Allies seized large quantities of this nerve agent. Up to the end of the war, Schrader and his co-workers synthesized about 2 000 new organo-phosphorus compounds, including sarin (1938). The third of the "classic" nerve agents, soman, was first produced in 1944. These three nerve agents are known as G agents in the American nomenclature. The manufacture of sarin never started properlyand up to 1945 only about 0.5 tonne of this nerve agent was produced in a pilot plant. Immediately after the war, research was mainly concentrated on studies of

the mechanisms of the nerve agents in order to discover more effective forms of protection against these new CW agents. The results of these efforts led, however, not only to better forms of protection but also to new types of agents closely related to the earlier ones. By the mid-1950's a group of more stable nerve agents had been developed, known as the V-agents in the American nomenclature. They are approximately ten-fold more poisonous than sarin and are thus among the most toxic substances ever synthesized. The first publication of these substances appeared in 1955. The authors, R. Ghosh and J.F. Newman, described one of the substances, known as Amiton, as being particularly effective against mites. At this time, intensive research was being devoted to the organo-phosphorus insecticides both in Europe and in the United States. At least three chemical firms appear to have independently discovered the remarkable toxicity of these phosphorus compounds during the years 1952-53. Surprisingly enough, some of these substances were available on the market as pesticides. Nonetheless, they were soon withdrawn owing to theirconsiderable toxicity also to mammals. In the United States, the choice fell in 1958 on a substance known by its code name VX as suitable as a CW agent of persistent type. Full-scale production of VX started in April 1961 but its structure was not published until 1972.

Physical and Chemical Properties

The most important nerve agents included in modern CW arsenals are:

•Tabun, O-ethyl dimethylamidophosphorylcyanide, with the American denomination GA. This nerve agent is the easiest to manufacture. Consequently, it is more likely that developing countries start their CW arsenal with this nerve agent whereas industrialized countries consider tabun to be out-of-date and of limited use.

•Sarin, isopropyl methylphosphonofluoridate, with the American denomination GB, a volatile substance mainly taken up through inhalation.
•Soman, pinacolyl methylphosphonofluoridate, with the American denomination GD, a moderately volatile substance which can be taken up by inhalation or skin contact.

•Cyclohexyl methylphosphonofluoridate, with the American denomination GF, a substance with low volatility which is taken up through skin contact and inhalation of the substance either as a gas or aerosol.

•O-ethyl S-diisopropylaminomethyl methylphosphonothiolate, better known under the American denomination VX, a persistent substance which can remain on material, equipment and terrain for long periods. Uptake is mainly through the skin but also through inhalation of the substance as a gas or aerosol.

The formulae for some nerve agents are:

•Tabun, GA: (CH3)2N-P(=O)(-CN)(-OC2H5)
•Sarin, GB: CH3-P(=O)(-F)(-OCH(CH33)2)
•Soman, GD: CH3-P(=O)(-F)(-CH(CH3)C(CH3)3
•GF: CH3-P(=O)(-F)(cyklo-C6H11)
•VX: CH3-P(=O)(-SCH2CH2N[CH(CH3)2]2)(-OC2H5)

The same type of phosphorus compounds are used as, for example, insecticides. In the structure of insekticides P(=O) has generally been replaced by P(=S) and a less reactive group than (-F), (-CN) or (-SCH2CH2N[CH(CH3)2]2) is used. All nerve agents in pure state are colourless liquids. Their volatility varies widely. The consistency of VX may be likened to an involatile oil and is therefore classified as belonging to the group of persistent CW agents. Its effect is mainly through direct contact with the skin. Sarin is at the opposite extreme, being an easily volatile liquid (comparable with, e.g., water), and mainly taken up through the respiratory organs. The volatilities of soman, tabun and GF are between those of sarin and VX. By addition of a thickener it is possible for, e.g., soman, to be transferred from the category of volatile CW agents to the persistent agents.

Sarin is very soluble in water whereas other nerve agents are more sparingly soluble. VX has the unexpected property of being soluble in cold water but sparingly soluble in warm water (>9.5 oC). The most important chemical reactions of nerve agents take place directly at the phosphorus atom. The P-X bond is easily broken by nucleophilic reagents, such as water or hydroxyl ions (alkali). In aqueous solution at neutral pH the nerve agents decompose slowly, whereas the reaction is greatly accelerated following the addition of alkali. The result is a non-toxic phosphoric acid. The pH-dependence on the rate of hydrolysis for sarin and VX at 25 oC expressed as half-life (hours). The curves have been calculated from laboratory experiments where pH was kept constant. On moist ground or snow, hydrolysis may be faster than shown in the figure as a result of auto-catalysis. The acidic hydrolysis products formed namely lead to a gradually lower pH and thus faster degradation.

The formation of the non-toxic phosphoric acid is also accelerated by rise in temperature or by a catalyst (e.g., hypochlorite ions from bleaching powder). This hydrolysis forms the basis of most decontamination procedures utilizing decomposition. In general, we may assume that an area exposed to G-agents decontaminates itself within a few days. However, V-agents may remain on the ground for several weeks because of their greater stability with respect to water and their much lower volatility. At pH-levels between 7 and 10 large quantities of VX are transformed into an extremely non-volatile product of hydrolysis which is incapable of penetrating skin. Admittedly, this is less toxic than VX but still implies a risk during decontamination. The nucleophilic attack on the phosphorous atom (P) also forms the basis of different types of coulour reaction used in detecting nerve agents.

Binary Technology

Most chemical ammunition can be described as unitary, which implies that it contains one active ready-to-use CW agent. Binary technology implies that the final stage in the synthesis of the nerve agent is moved from the factory into the warhead, which thus functions as a chemical reactor. Two initial substances which are stored in separate containers are mixed and allowed to react and form the nerve agent when the ammunition (bomb, projectile, grenade, etc.) is on its way towards the target. Until the actual moment of use, the ammunition contains only relatively non-toxic initial substances. It is therefore considered to be safer to manufacture, store, transport and, finally, destroy. However, some critics question whether this practically untested type of new ammunition is reliable. The technique for mixing substances in bombs and rockets is complicated and requires space. The reaction has to be controlled (e.g., thetemperature) and the process should preferably take place without solvents. The principle for the use of binary weapons. Two canisters with the two liquid components are placed one after the other in the shell. When the shell is fired, forces of inertia willpress the liquid contents in the front canister backwards and burst the wall separating the canisters. The rifling in the barrel gives the shell a spinning velocity ofabout 15,000 r.p.m. which contributes to the mixing.

In 1991 Iraq declared to the United Nations Special Commission (UNSCOM) a different binary munitions concept. According to this the munitions were stored containing one component. Shortly before use the munitions were opened and the second component was added. Thus the reaction began even before the munitions were launched. Binary components for the three most common nerve agents (American code names are given in brackets) are the following:

•Sarin (GB-2): methylphosphoryldifluoride (DF) + isopropanol. The isopropanol is included in a mixture (OPA) with isopropylamine which binds the hydrogen fluoride generated.

•Soman (GD-2): methylphosphoryldifluorid (DF) + pinacolylalcohol.

•VX-2: O-ethyl O-2-diisopropylaminoethyl methylphosphonite (QL) + sulphur.

Mechanism of Action

A characteristic of nerve agents is that they are extremely toxic and that they have very rapid effect. The nerve agent, either as a gas, aerosol or liquid, enters the body through inhalation or through the skin. Poisoning may also occur through consumption of liquids or foods contaminated with nerve agents. The route for entering the body is of importance for the period required for the nerve agent to start having effect. It also influences the symptoms developed and, to some extent, the sequence of the different symptoms. Generally, the poisoning works faster when the agent is absorbed through the respiratory system than via other routes. This is because the lungs contain

numerous blood vessels and the inhaled nerve agent can therefore rapidly diffuse into the blood circulation and thus reach the target organs. Among these organs, the respiratory system is one of the most important. If a person is exposed to a high concentration of nerve agent, e.g., 200 mg sarin/m3 (see table) death may occur within a couple of minutes. Poisoning takes longer when the nerve agent enters the bodythrough the skin. Nerve agents are more or less fat-soluble and can penetrate the outer layers of the skin. However, it takes some time before the poison reaches the deeper blood vessels. Consequently, the first symptoms do not occur until 20-30 minutes after the initial exposure but subsequently the poisoning process may be rapid if the total dose of nerve agent is high. The toxic effect of nerve agents depends on them becoming bound to an enzyme, acetylcholinesterase, and thereby inhibit this vital enzyme's normal biological activity in the cholinergic nervous system.

Symptoms

When exposed to a low dose of nerve agent, causing minor poisoning, characteristic symptoms are increased production of saliva, a running nose and a feeling of pressure on the chest. The pupil of the eye becomes contracted (miosis) which impairs night-vision. The accommodation capacity of the eye is also reduced so that short-range vision deteriorates and the victim feels pain when he tries to focus on an object nearby. This is accompanied by headache. More unspecific symptoms are tiredness,slurred speech, hallucinations and nausea.

Exposure to a higher dose leads to a more dramatic development and symptoms are more pronounced. Bronchoconstriction and secretion of mucous in the respiratory system leads to difficulty in breathing and to coughing. Discomfort in the gastrointestinal tract may develop into cramp and vomiting. Involuntary discharge of urine and defecation may also form part of the picture. The discharge of saliva is powerful and the victim may experience running eyes and swetting. Symptoms from the skeletal muscles are very typical. If the poisoning is moderate, this may express itself as muscular weakness, local tremors or convulsions. When exposed to a highdose of nerve agent, the muscular symptoms are more pronounced. The victimmay suffer convulsions and lose consciousness. To some extent, the poisoning process may be so rapid that earlier mentioned symptoms may never have time to develop. Muscular paralysis caused by nerve agents also affects the respiratory muscles. Nerve agents also affect the respiratory centre of the central nervous system. The combination of these two effects is the direct cause of death. Consequently, death caused by nerve agents is a kind of death by suffocation.

The figure shows examples of poisoning results caused by different doses of sarin vapour. In similarity to other poisons, different individuals are more or less sensitive to nerve agents. The figure shows that the lethal dose for the most sensitive individuals is about 70 mg.min/m3 and about twice this level for more resistant people. The toxic effect depends on both the concentration of nerve agent in the air inhaled (C) and the time of exposure (t). In extremely high concentrations there is a simple relationship, C

t, which gives a certain toxic effect. Inhalation of sarin vapour with a concentration of 100 mg/m3 for one minute gives the same result as inhalation of 50 mg/m3 for two minutes. However, at low concentrations this relationship does not apply since the human body is capable of some degree of detoxification. In order to obtain a corresponding effect, it is then necessary to have relatively longer periods of exposure. The values given in the table for toxicity of nerve agents apply to high concentrations.

Antidotes and Methods of Treatment

Nerve agents have an extremely rapid effect. If medical methods of treatment are to serve any purpose, they must be introduced immediately. In many countries; the armed forces have access to an auto-injector containing antidotes to nerve agents. It is so simple to use that the soldier can easily give himself or another person an intramuscular injection.

The Swedish auto-injector.

One example is the Swedish auto-injector, which contains two active components: HI-6 (500 mg) and atropine (2 mg). HI-6 is an oxime which directly reacts with the cause of the injury, i.e., nerve agent-inhibited acetylcholinesterase. HI-6 functions as a reactivator which restores the enzyme to an operational condition. Oximes have a poor penetration capacity into the brain and thus mainly work in the peripheral nervous system.

The various nerve agents cause poisoning which are more or less easy to treat with oximes. From this standpoint, VX and sarin are the easiest to treat and all oximes used increase the chances of surviving poisoning with these nerve agents. Obidoxime is the most effective against tabun poisoning but also HI-6 has a positive effect. Soman causes the most difficultly treated poisoning and can only be treated with HI-6. Soman poisoning is complicated by the inhibited enzyme going through an "ageing" process. Following the ageing the enzyme cannot be reactivated by any oxime. It is possible that HI-6 has some further positive antidote effect in addition to its reactivating ability.

The other active component in the auto-injector is atropine. Atropine is the classical antidote in cases of poisoning by organo-phosphorus compounds. It is a medication which releaves the symptoms but does not attack the cause of the injury. Atropine becomes bound to the receptors for acetylcholine, which are present in the cholinergic synapse. When acetylcholine is bound, the signal is transmitted but if atropine has become bound to the receptor, then no such transmission takes place. Atropine thus gives protection against the excess of acetylcholine which results from inhibition of acetylcholinesterase. Atropine has effects only within certain parts of the cholinergic nervous system. There are two types of acetylcholine receptors, the nicotinic which are found, e.g., in the skeletal muscles, and the muscarinic, which are found in, e.g., smooth muscles, glands and the central nervous system. Atropine blocks the muscarinic receptors. Atropine and oxime may therefore be considered to complement

each other and the two antidotes also have a synergetic effect, i.e., they boost each other. An additional auto-injector can be given to victims of nerve agents if their situation does not improve within ten minutes. Subsequently, the victim should be treated by qualified medical staff who should initially inject additional atropine and an anti-convulsant drug, diazepam. In cases of severe poisoning by nerve agents, large doses of atropine (grammes) may be required. The level of operationalacetylcholinesterase is gradually restored by the body's own productionbut this process requires at least two weeks. During this period, and possibly also later, the victim may require medical care not only for mental disorders such as difficulty in sleeping, amnesia, difficulties in concentrating, and anxiety, but also for muscular weakness. Mental problems may also occur efter long exposure to extremely low concentrations to nerve agents.

There are also medical antidotes which can be taken preventively. These antidotes are taken as tablets and used when ordered in connection with maximum C-preparedness. One of the tablets contains a carbamate, pyridostigmine, as active ingredient. Pyridostigmine inhibits acetylcholinesterase and protects the enzyme against inhibitory effects of nerve agents. The dose is low and leads to about 25 per cent inhibition. The pyridostigmine-inhibited enzyme is continuously released to active state and thereby can reasonably effectively maintain the transfer of nerve impulses despite injury caused by nerve agents. The effect is restricted to the peripheral cholinergic nervous system since the substance does not enter the brain. Pyridostigmine does not cause any side effects since there is a large excess of enzyme in the cholinergic synapse. In actual fact, 1-2 per cent of functional enzyme is sufficient to have a functioning synapse. This explains why carbamate pretreatment has such good effect. Pretreatment with carbamate should be combined with oxime therapy (the auto-injector) after the poisoning in order to provide maximum effect. This combination reduces the toxic effects of all nerve agents. A diazepam tablet is also generally given as a pretreatment, primarily affecting the central nervous system. Diazepam strengthens the effect of other nerve agent antidotes. There will be better prospects of survival and less injury. Diazepam also provides protection against permanent brain damage which may result from heavy exposure to nerve agents. Pretreatment has best effect if a warning system is available and operative, since the tablets need about 30 min. to have effect after being swallowed. The best protective effect is achieved after about two hours, which is followed by decreasing efficacy. If the situation so requires, treatment can be repeated at eight-hourly intervals for some days. The tablets should not be taken once nerve agent injury has occurred. Admittedly, diazepam has a positive effect but pyridostigmine at that stage will aggravate the injury.

Toxicity of the most important nerve agents to man

	LCt50 Inhalation mg.min/m3	LD50 Skin mg/individual
Tabun	200	4,000
Sarin	100	1,700
Soman	100	300
VX	50	10

The values are estimates of the doses which have lethal effects on man. LD50 expresses the dose at which 50 per cent of the exposed population will die as a result of their injuries. A different measure is used for inhalation, the product of the concentration (C) and the length of exposure (t). Again, L stands for lethal and 50 for 50 per cent effect. The toxicity sequence is the same for the two routes of exposure but the differences are much greater in skin exposure. This is mainly caused by the more volatile nerve agents evaporating from naked skin. If the evaporation is prevented, e.g., by tightly fitting clothing, the difference will be less.

Physical Properties of Nerve Agents

Effect of Nerve Agents and Antidotes on the Enzyme Acetylcholinesterase

The toxic effect of nerve agents depends on the substance inhibiting the enzyme acetylcholinesterase in the cholinergic nerve system. This enzyme is responsible for breaking down the signal substance acetylcholine, a process requiring two steps - acetylation by means of a serine in the active site and hydrolysis:
Enzyme-OH + CH3C(=O)-O-(CH2)2-N+(CH3)3
reacts with the release of choline to give
Enzyme-O-C(=O)-CH3
which is rapidly hydrolysed to
Enzyme-OH + CH3COOH

Degradation of the signal substance in the cholinergic synapse takes place extremely rapidly depending on the enzyme being available in large amounts and also since it is extremely effective. Under optimum conditions, each enzyme molecule hydrolyzes about 15 000 acetylcholine molecules per second. The reaction mechanism for nerve agents is similar but with the important difference that the rate of the final, hydrolyzing step is negligible. Consequently, the enzyme becomes irreversibly inhibited, with thenerve agent covalently bound to the enzyme via the serine in the active site.

Enzyme-OH---X-P(=O)(R1)(-OR2)
releases X- to give
Enzyme-O-P(=O)(R1)(-OR2)

Inhibition of acetylcholinesterase is thus a progressive process and the degree of inhibition depends not only on the concentration of nerve agent but also on the time of exposure. Soman is the most potent inhibitor of acetylcholinesterase among the nerve agents. A concentration of 10-9 M is sufficient to inhibit the enzyme by more than 50 per cent within 10 minutes.

Reactivation Using Oxime

Oximes, with the general formula R-CH=NOH, can reactivate the phosphorylated enzyme. The oxime attacks the P-O bond whereby an operational enzyme and a phosphorylated oxime, which is rapidly hydrolyzed to non-toxic products, are formed. The efficiency of such reactivation depends strongly on the types of all the three components involved - enzyme, oxime and nerve agent.

"Ageing"

In the "ageing" reaction, the phosphorylated enzyme is dealkylated:
Enzyme-O-P(=O)(R1)(-OR2)
reacts to give
Enzyme-O-P(=O)(R1)-OH

The reaction is catalyzed by the enzyme itself and the reaction may be extremely fast. Soman-inhibited acetylcholinesterase becomes "aged" within a few minutes. After the "ageing", the inhibited enzyme is even more resistant to hydrolysis and reactivation with oxime is without effect.

Pretreatment With the Carbamate Pyridostigmine

Carbamates, with the general formula R1R2-N-C(O)-O-R3, inhibit acetylcholinesterase. They carbamylate the enzyme with a mechanism analogous to the substrate and nerve agent reactions. The carbamylated enzyme hydrolyzes slowly with a half-life of about 30 minutes.

Mustard Agents

An overview of the sulfur and nitrogen mustard agents

Mustard agents are usually classified as "blistering agents" owing to the similarity of the wounds caused by these substances resembling burns and blisters. However, since mustard agents also cause severe damage to the eyes, respiratory system and internal organs, they should preferably be described as "blistering and tissue-injuring agents". Normal mustard agent, bis-(2-chloroethyl)sulphide, reacts with a large number of biological molecules. The effect of mustard agent is delayed and the first symptoms do not occur until between 2-24 hours after exposure. Mustard agent was produced for the first time in 1822 but its harmful effects were not discovered until 1860. Mustard agent was first used as a CW agent during the latter part of the First World War and caused lung and eye injuries to a very large number of soldiers. Many of them still suffered pain 30-40 years after they had been exposed, mainly as a result of injuries to the eyes and chronic respiratory disorders. Towards the end of the Second World War a large number of soldiers and sailors were injured during a German attack on the Italian port of Bari. A cargoship loaded with mustard agent ammunition was hit and large amounts of mustard agent became mixed with the water. The victims swam around in the contaminated water but it was not realized until too late that a large number of people had been injured by mustard agent. The Bari Incident served as a macabre illustration of the delayed effect of mustard agent. During the war between Iran and Iraq in 1979-88, Iraq used large quantities of chemical agents. About 5 000 Iranian soldiers have been reported killed, 10-20 per cent by mustard agent. In addition, there were 40 000 to 50 000 injured. A typical result of warfare with mustard agent is that the medical system is loaded with numerous injured who require long and demanding care. One of the Iranian soldiers who were treated for mustard agent burns in a Swedish hospital. The photo shows extensive injury, several weeks old, which is now starting to heal. Incidents are still occurring annually in the neighbourhood of Sweden where people risk injury from mustard agent. This largely involves fishermen who are exposed to mustard agent brought to the surface by fishing nets. The background is found in the dumping of chemical weapons after the Second World War in waters off the Danish and Swedish coasts. Many fishing ports in south Sweden and Denmark have resources to care for injured people and to decontaminate equipment contaminated by mustard agent. Certain resources are also available on the fishing vessels.

Mustard agent is very simple to manufacture and can therefore be a "first choice" when a country decides to build up a capacity for chemical warfare. Apart from mustard agent, there are also several other closely related compounds which have been used as chemical weapons. During the 1930's, several reports were published on the synthesis of nitrogen mustard agent and its remarkable blistering effect. The mechanism of action and symptoms largely agree with those described for mustard agent. Germans and Americans started the military production of nitrogen mustard agent in 1941 and 1943, respectively, whereas the development in England was

abandoned following an explosion. There is no verified use of nitrogen mustard agents as chemical weapons and their usefulness is restricted by these types of agents being unsuitable for storage.

Physical and Chemical Properties

In its pure state, mustard agent is colourless and almost odourless. The name was given to mustard agent as a result of an earlier production method which yielded an impure mustard-smelling product. Mustard agent is also claimed to have a characteristic smell similar to rotten onions. However, the sense of smell is dulled after only a few breaths so that the smell can no longer be distinguished. In addition, mustard agent can cause injury to the respiratory system in concentrations which are so low that the human sense of smell cannot distinguish them. At room temperature, mustard agent is a liquid with low volatility and is very stable during storage. The melting-point for pure mustard agent is 14.4 oC. In order to be able to effectively usemustard agent at lower temperatures, it has been mixed with lewisite in some types of ammunition in a ratio of 2:3. This mixture has a freezing-point of -26 oC. During the Second World War, a form of mustard agent with high viscosity was manufactured by means of the addition of a polymer. This is the first known example of a thickened CW agent.

Mustard agent can easily be dissolved in most organic solvents but has negligible solubility in water. In aqueous solutions, mustard agent decomposes into non-poisonous products by means of hydrolysis. This reaction is catalyzed by alkali. However, only dissolved mustard agent reacts, which means that the decomposition proceeds very slowly. Bleaching-powder and chloramines, however, react violently with mustard agent, whereupon non-poisonous oxidation products are formed. Consequently, these substances are used for the decontamination of mustard agent.

Mechanism of Action

The toxic effects of mustard agent depend on its ability to covalently bind to other substances. The chlorine atom is spiked off the ethyl group and the mustard agent is transferred to a reactive sulphonium ion. This ion can bind to a large number of different biological molecules. Most of all it binds to nucleophiles such as nitrogen in the base components of nucleic acids and sulphur in SH-groups in proteins and peptides. Since mustard agent contains two "reactive groups", it can also form a bridge between or within molecules. Mustard agent can destroy a large number of different substances in the cell by means of alkylation and thereby influence numerous processes in living tissue.

Symptoms

In the form of gas or liquid, mustard agent attacks the skin, eyes, lungs and gastro-intestinal tract. Internal organs may also be injured, mainly blood-generating organs,

as a result of mustard agent being taken up through the skin or lungs and transported into the body. The delayed effect is a characteristic of mustard agent. Mustard agent gives no immediate symptoms upon contact and consequently a delay of between two and twenty-four hours may occur before pain is felt and the victim becomes aware of what has happened. By then cell damage has already been caused. Symptoms of mustard agent poisoning extend over a wide range. Mild injuries consist of aching eyes with abundant flow of tears, inflammation of the skin, irritation of the mucous membrane, hoarseness, coughing and sneezing. Normally, these injuries do not require medical treatment. Severe injuries which are incapacitating and require medical care may involve eye injuries with loss of sight, the formation of blisters on the skin, nausea, vomiting and diarrhoea together with severe respiration difficulty. A Baltic fisherman with a relatively fresh mustard agent injury. The photo was taken at Bornholm Hospital, Denmark, by Dr. Steen Christensen.

Acute mortality arising from exposure to mustard agent is low. The dose needed to directly kill a person upon inhalation is, e.g., about 50 times larger than the dose giving acute mortality upon poisoning with the nerve agent soman. People who die after exposure to mustard agent usually do so after a few days up to one or more weeks. Minor skin damage may be caused by mustard agent in the gaseous state whereas the most severe injuries are caused after contact with liquid mustard agent. Skindamage first appears as a painful inflammation. Depending on the level of exposure, the injury may develop into pigmentation, which flakes-off after a couple of weeks, small surface blisters or deep liquid-filled blisters with subsequent skin necrosis. In extreme cases, the skin necrosis may be so comprehensive that no blisters occur. Skin injuries are more severe in humid and warm climates. Similarly, the injuries will be more severe where the skin is moist and warm, e.g., in the groin and armpits. Experience has shown that even extremely extensive skin damage, 80-90 %, can be cured if the patient is kept free of infection. However, injuries to the skin require a very long period of recuperation, much longer than thermal burns, and may require care and plastic surgery over a period of several months. Injury to the eyes appear initially as irritation with eye inflammation and a strong flow of tears. Depending on exposure, the symptoms thereafter may successively develop to sensitivity to light, swollen eyelids, and injury to the cornea. Severe damage to the eyemay lead to the total loss of vision. Victims suffering damage to the eyes may encounter problems persisting up to 30-40 years following exposure. The most common cause of death as a result of mustard agent poisoning is complications after lung injury caused by inhalation of mustard agent. Lung injuries become apparent some hours after exposure and will first appear as a pressure across the chest, sneezing and hoarseness. Severe coughing and respiration difficulties caused by pulmonary oedema will gradually occur and after a couple of days, a "chemical pneumonia" may develop. Most of the chronic and late effects are also caused by lung injuries. The effect on inner organs which is most pronounced is injury to the bone marrow, spleen and lymphatic tissue. This may cause a drastic reduction in the number of white blood cells 5-10 days after exposure, a condition very similar to that after exposure to radiation. This reduction of the immune defence will complicate the

already large risk of infection in people with severe skin and lung injuries.

Antidotes and Methods of Treatment

There is no treatment or antidote which can affect the basic cause of mustard agent injury. Instead, efforts must be made to treat the symptoms. By far the most important measure is to rapidly and thoroughly decontaminate the patient and thereby prevent further exposure. This decontamination will also decrease the risk of exposure to staff. Clothes are removed, the skin is decontaminated with a suitable decontaminant and washed with soap and water. If hair is suspected to be contaminated then it must be shaved off. Eyes are rinsed with water or a physiological salt solution for at least five minutes. In medical treatment, efforts are made to control infections by means of antibiotics. Pain can be eased by local anesthetics. After skin injuries have healed, it may be necessary to introduce plastic surgery. Lung injuries are treated with bronchodilatory treatment. Medicine to relieve coughing and also cortisone preparations may be used. Eye injuries are treated locally with painkillers and with antibiotics if required. Despite treatment, inflammation and light sensitivity may remain for long periods. Modern knowledge on the mechanisms behind mustard agent injuries may lead mainly to new ways of treatment. The first step, alkylation, takes place extremely rapidly and is probably very difficult to influence. Future treatment may concentrate on suppressing and alleviating the development of symptoms and thereby improve the opportunities for good recovery.

Types of Injury Caused by Mustard Agent

It is impossible to identify a single mechanism for the damage caused by mustard agent. However, two possible important mechanisms can be mentioned where the first step in both is the formation of a reactive sulphonium ion. One such mechanism is the bonding of mustard agent to the base compounds in DNA (alkylation). The bonding may induce breakages of strands and the formation of bridges between the two strands in the DNA molecule. Bridges of this kind prevent DNA from functioning normally during cell division which may lead to severe injury and possibly cell mortality. Damage to the DNA may also lead to mutations and disturbance to the natural repair mechanisms of DNA. The influence on DNA can cause the increased frequency of cancer observed after exposure to mustard agent. The other mechanism of action is interaction between mustard agent and intracellular glutathion. Glutathion is a small peptide molecule which, among other things, takes care of the free radicals formed during cell respiration. If too large an amount of glutathion is bound by mustard agent, then the regulation of these free radicals no longer functions. Since free radicals are extremely toxic, this may lead to a number of processes in the cell being severely disturbed. Mustard agent can also bind to different proteins in the cell. However, it is not known how much this contributes to the injuries caused. The binding takes place at the functional groups, e.g., the sulphydryl or amino groups. If the

bindingis made to, for example, the active site of enzymes, then their activity is inhibited which could lead to metabolic disorders. If, on the other hand, membrane proteins are bound, the result can be a modified uptake of substances and the inner environment of the cell will become disturbed.

Physical Properties of Mustard Agent

Molecular weight, Dalton159.1 Density, g/cm31.27 Boiling-point oC 217
Melting-point oC14 Vapour pressure mm Hg at 25 oC0.11 Volatility mg/m3
at 25 oC900 Solubility in water % at 20 oC0,06

Toxicity of Mustard Agent

Inhalation: LCt50 1 500 mg*min/m3
Skin exposure: LCt50 10 000 mg*min/m3
Smallest blister-causing dose on skin: 0,02 mg

Hydrogen Cyanide

Hydrogen cyanide is usually included among the CW agents causing general poisoning. There is no confirmed information on this substance being used in chemical warfare. However, it has been reported that hydrogen cyanide was used by Iraq in the war against Iran and against the Kurds in northern Iraq during the 1980's. Hydrogen cyanide has high toxicity and in sufficient concentrations it rapidly leads to death. During the Second World War, a form of hydrogen cyanide (Zyklon B) was used in the Nazi gas chambers. At room temperature, hydrogen cyanide is a colourless liquid which boils at 26 oC. The most important route of poisoning is through inhalation. Both gaseous and liquid hydrogen cyanide, as well as cyanide salts in solution, can also be taken up through the skin. Its high volatility probably makes hydrogen cyanide difficult to use in warfare since there are problems in achieving sufficiently high concentrations outdoors. On the other hand, the concentration of hydrogen cyanide may rapidly reach lethal levels if it is released in confined spaces. The most important toxic effect of hydrogen cyanide is by inhibiting the metal-containing enzymes. One such enzyme is cytochromoxidase, containing iron. This enzyme system is responsible for the energy-providing processes in the cell where oxygen is utilized, i.e., cell respiration. When cell respiration ceases, it is no longer possible to maintain normal cell functions, which may lead to cell mortality. Symptoms of cyanide poisoning vary and depend on, for example, route of poisoning, total dose and the exposure time. If hydrogen cyanide has been inhaled, the initial symptoms are restlessness and increased respiratory rate. Other early symptoms are giddiness, headache, palpitations and respiratory difficulty. These are later followed by vomiting, convulsions, respiratory failure and unconsciousness. If the poisoning occurs rapidly, e.g., as a result of extremely high concentrations in the air, there is no time for symptoms to develop and exposed persons may then suddenly collapse and die. Today, there is no medical antidote against cyanide poisoning within the Swedish Armed Forces. The treatment given to civilians is based on encouraging and speeding-up the body's own ability to excrete cyanide and to bind cyanide in the blood. The enzyme rhodanese is present in the body, mainly in the liver, and together with sulphur transforms cyanide into thiocyanate, which is passed out in the urine. By supplying sulphur in the form of sodium thiosulphate ($Na_2S_2O_3$) the detoxification can be speeded up. The cyanide ion has high affinity to trivalent iron (Fe^{3+}). The divalent iron in blood haemoglobin can be oxidized to trivalent, which leads to the formation of methaemoglobin which binds cyanide ions. The formation of methaemoglobin can be achieved by supplying sodium nitrate ($NaNO_2$) or dimethylaminophenol (DMAP). Cyanide can also be bound by metallic ions supplied to the blood in suitable form. Among others, cobalt can be supplied in the form of a cobalt complex or as hydroxycobalamin (vitamin B12). In cases of poisoning with hydrogen cyanide it is of the utmost importance that countermeasures are immediately introduced. For this reason, a medical antidote (PAPP, para-aminopropiophenone) for use as a pretreatment is being developed in the United Kingdom.

Relationship between concentration and effects when inhaling hydrogen

cyanide

Concentration (mg/m3)	Effect
300	Immediately lethal
200	Lethal after 10 minutes
150	Lethal after 30 minutes
120-150	Highly dangerous (fatal) after 30-60 min.
50-60	Endurable for 20 min. - 1 h without effect
20-40	Light symptoms after several hours

Arsines

Some arsenic compounds which are potential chemical weapons

Among the arsenal of chemical weapons can be found mustard agent mixed with lewisite which is an aliphatic arsenic compound, 2-chlorovinyldichloroarsine. Pure lewisite is a colourless liquid. Solubility in water is approximately the same as for mustard agent but the volatility is much higher. Hydrolysis in water is faster than for mustard agent. Injuries caused by lewisite are similar to those caused by mustard agent. However, the mechanism of action for lewisite is different. From the diagnostic viewpoint, an important difference is that symptoms in lewisite poisoning are not delayed and the irritating effect occurs immediately. Skin damage is treated in the same way as after exposure to mustard agent. A specific antidote (BAL, British Anti Lewisite, dimercaptopropanol) gives good protection against local injuries to skin and mucous membrane. BAL also has effect against systemic poisoning. Other arsenic containing substances have also been of interest as CW agents. One example is adamsite, 10-chloro-5,10-dihydrophenarsazine, which is a nasal and throat-irritating powder.

Toxins

Potential chemical weapons from living organisms

Toxins are effective and specific poisons produced by living organisms. They usually consist of an amino acid chain which can vary in molecular weight between a couple of hundred (peptides) and one hundred thousand (proteins). They may also be low-molecular organic compounds. Toxins are produced by numerous organisms, e.g., bacteria, fungi, algae and plants. Many of them are extremely poisonous, with a toxicity that is several orders of magnitude greater than the nerve agents. Toxins started to attract military interest already during the first half of the present century. At that time, it was difficult to manufacture sufficiently large amounts of toxin which caused interest to decrease. Many of the toxins discussed at that time were sensitive to heat and light which made them unstable and unpractical to use. The U.S.A. ended its toxin programme in the late 1960's and destroyed its stockpile of, e.g., botulinum toxin. The Biological and Toxin Weapons Convention of 1972 prohibits the development, production and stockpiling of toxins as weapons. The 1925 Geneva Protocol prohibition of use of chemical and bacteriological weapons also covers the use of weapons based on toxins. Since the definition of chemical weapons includes toxins they are also covered by the Chemical Weapons Convention. In the late 1970's, there was a rapid development of gene technology together with biotechnology. This led to the threat from toxins as CW agents again arising. Now it became possible to produce greater amounts of many toxins more easily, in some cases even synthetically. Gene technology can be used to modify the toxin genes so that the end product obtains new properties and, for example, may become less sensitive to sunlight. Together with increased research into toxins, the bioregulators have also been studied and synthesized. Bioregulators are naturally-occurring substances, usually peptides, which participate in the physiological and neurological activities of the body. These substances can also be modified synthetically, whereupon they may obtain new properties. The scientific and commercial development have together provided increased opportunities to incorrectly utilize biotechnology for military purposes. Recent research, for example, has made it possible to "target" toxins to different body organs or structures. This new knowledge mainly emanates from civilian research into, e.g., the treatment of cancer patients. Toxins are still considered to be less suitable for dispersal on a large scale. Nonetheless, they could be used for sabotage or in especially designed inputs, e.g., against key persons. Since toxins have low volatility, they are dispersed as aerosols and then taken up foremost through inhalation. The new microencapsulation technology, which is easy to use, makes it possible to protect unstable toxins when dispersed. Most toxins are unstable in alkaline water solutions and are thus easily destroyed by means of normal decontamination methods. A few examples of toxins which may be used as chemical warfare agents are listed below. The trichothecenes, mycotoxins obtained from, e.g., Fusarium genera, were alleged in the early 1980's to have been used as CW agents in Southeast Asia ("yellow rain"), but are of no military value today.

Bacterial Toxins

Botulinum toxin, produced by the bacteria Clostridium botulinum, is the most poisonous substance known. The bacteria grows on, e.g., poorly preserved food and causes a severe form of food-poisoning (botulism). The incubation period is between one and three days after which the victim becomes ill with stomach pains, diarrhoea, disturbances to vision, giddiness and muscular weakness. The whole body including the respiratory musculature becomes paralyzed which leads to death by suffocation within a few days. The toxin is a protein available in seven different forms, where the most poisonous is type A (molecular weight = 150,000 D). The lethal dose to man has been estimated to about one microgram if ingested and even less if inhaled. It is possible to vaccinate against botulism but once the victim has become poisoned there is no antidote. Botulinum toxin is today commercially produced and is used in treating squinting and other muscular disorders.

Not all toxins have a lethal outcome. One of those classified in the incapacitating group is Staphylococcus enterotoxin type B (SEB), which is produced by Staphylococcus aureus bacteria. SEB is the toxin which is most commonly found to have caused food poisoning. SEB is a protein (molecular weight = 28,500 D), which is easily soluble in water and relatively stable. It can withstand boiling for a couple of minutes and when in freeze-dried state, it can be stored for more than one year. Persons exposed to SEB (20-25 g) fall ill after a few hours with typical food poisoning symptoms, such as stomach cramp, diarrhoea and vomiting. The sufferer frequently recovers without special treatment within 24 h.

Many toxins are produced by marine organisms. One such example is saxitoxin, which is synthesized by a type of blue-green algae (cyanobacteria). These algae provide food for different shellfish, e.g., mussels. The mussels themselves are not influenced by the poison, but human beings who later eat the mussels may become seriously ill. Saxitoxin attacks the nervous system and has a paralyzing effect, but causes no symptoms in the gastro-intestinal tract. The development of the illness is extremely rapid and at high doses death may occur within less than 15 minutes. The LD50 for man is at about 1 mg. Saxitoxin is a small molecule with a molecular weight of 370 D. It is not sensitive to heat but is destroyed by oxygen. Saxitoxin is included in Schedule 1 of the Chemical Weapons Convention.

Plant Toxins

The seeds of the castor oil plant can be used to extract a mixture of poisonous proteins, ricin. One of these has also been produced by Escherichia coli bacteria to which the ricin gene has been transferred. Ricin became of interest as a CW agent at an early stage as it is relatively easy to produce in large quantities. In 1978, it was used in the "umbrella murder" in London where a ricin-treated bullet was used to shoot

a Bulgarian defector who died within a day. Ricin is now included in Schedule 1 of the Chemical Weapons Convention. Ricin poisoning occurs through blockages of the body's synthesis of proteins. The development is slow and includes decreased blood pressure. Death frequently occurs through heart failure. Ricin has approximately the same toxicity as saxitoxin. Different forms of ricin bound to, e.g., monoclonal antibodies are being studied today in order to treat leukaemia and cancer of the liver.

Bioregulators

During recent years, discussions have started on the risk of bioregulators being used as CW agents. These types of substances do not belong to the group of toxins but are, nonetheless, grouped with them since their possible use is similar. They are closely related to substances normally found in the body and may be algogenic (causing pain), anaesthetic, or influencing blood pressure. A characteristic of them is that they are active in extremely low doses and frequently have rapid effect.

One example of this group of substances is Substance P, a polypeptide (molecular weight = 1,350 D) which is active in doses of less than one microgramme. Substance P causes, for example, a rapid loss of blood pressure which may cause unconsciousness.

Chemical Accidents

Causes, effects and important influencing factors

In society today, large amounts of chemicals are routinely stored, handled and transported. Some of these are products ready for marketing whereas others are used in further processing. The handling of chemicals is controlled by laws and regulations designed to minimize the risk of injury to humans, the environment and to property. However, this system of regulations provides no guarantee that an accident will not occur. Not all chemical substances imply similar risks when released. Risk chemicals are classified according to several different criteria, e.g.:
•range effect,
•toxicity,
•size of production, storages and transports,
•chemical stability.

The number of people who will be injured following the release of chemicals, and the extent of the damage, will depend on numerous factors. Some factors are the properties of the substance, the size of the discharge, the period during which people are exposed, and the length of time that passes between exposure and treatment. The most important risk chemicals are gases, in many countries especially the irritants chlorine, sulphur dioxide, ammonia and hydrogen chloride. These substances have relatively high toxicity when inhaled and they are produced, stored and transported in large volumes. Production establishments and stockpiles are frequently located in the proximity of housing areas. The substances generated during fires imply a special problem, particularly with regard to fires in chemical stockpiles. Here, several substances may be generated which imply risks both to humans and to the environment.

Gases

Irritants were used as chemical weapons during the First World War. The gases then used were chlorine and phosgene. In the same way as ammonia, sulphur dioxide andhydrogen chloride, they cause irritation to eyes, throat and airways. Ammonia, sulphur dioxide and hydrogen chloride are easily soluble in water and therefore have their main effect in the mucous membrane of the upper airways. These gases also have a strongly irritating effect on the eyes. Chlorine, on the other hand, which has low solubility in water, is taken up only to a minor extent in the upper airways. Consequently, chlorine gas reaches the lungs in relatively high concentrations. Normal symptoms of poisoning by irritants are running eyes, coughing, a feeling of suffocation, pain when inhaling, and a feeling of general incapacitance. Attacks on lung tissue may, in addition, lead to pulmonary oedema, i.e., abnormal accumulation of liquid in the lung tissue. Pulmonary oedema hinders the exchange of gas in the lungs and also leads to increased strain on the heart. The cause of death in cases of poisoning by substances injurious to the lungs is often a combination of reduced

function of the lungs and collapse of the heart. At very high concentrations, death by suffocation may occur as a result of cramp of the larynx. Pulmonary oedema following poisoning with harassing agents develops fully some hours or about a day after exposure. Even after exposure to very high doses, a period of up to several hours may pass during which only mild symptoms are noticed. Consequently, there is a risk that a potentially lethal poisoning may initially be disregarded.

Treatment after poisoning with harassing agents concentrates on preventing the development of pulmonary oedema. The victim is removed as soon as possible from the area where the gases are present and gas-polluted clothing is removed. The victim must not be exposed to physical exertion. Oxygen is supplied if necessary, together with substances to widen the bronchi, and possibly also cortisone preparations. Serious cases of poisoning may require intensive care. It is important to remember that even if the early symptoms are no more than a persistent cough, the victim should be carefully watched for at least 24 hours, enabling any pulmonary oedema to be given treatment in time. In cases of lung injury, there is also the risk of complications in the form of more severe infections than normal.

Increased knowledge

Planning of society places great value on having knowledge of how chemicals behave in situations of uncontrolled discharge. Such knowledge can be obtained in several ways, e.g., by learning from experiences in other countries. An accident which has been devoted much study is the one at Bhopal, India, where methylisocyanate was released in large quantities The disastrous consequences of this accident were caused by several factors, three of which can be mentioned, where lessons for the future may be learnt.

Firstly, the standard of the factory's technical equipment was poor and the maintenance appeared to have been neglected. Secondly, the urban area in which most of the victims were found was in the immediate proximity of the factory. Thirdly, the people who suffered were among the poorest in Indian society. Their dwellings were of very low standard and provided no protection against the drifting cloud of gas. Another way of improving knowledge of chemical release is to make simulations. By means of computerized models, it is possible today to make reasonably good predictions of the effect of a release of gas.

The Bhopal accident

Massive discharge of a chemical took place at Union Carbide's factory at Bhopal, Madya Pradesh, India, during the night of 2 December 1984. The accident started when a tank containing methylisocyanate (MIC) started to leak. MIC is an extremely reactive chemical and is used in production of the insecticide carbaryl. The accident developed into the largest industrial disaster ever to occur. About one-third of the town's total population of 800 000 were afflicted. About 100 000 of these received

some kind of medical treatment, about 50 000 were hospitalized and about 2 500received lethal injuries. In addition, about 7 000 animals were injured, of which about one thousand were killed. MIC (CH3NCO) is a volatile fluid with a boiling-point of about 40 oC. Because of its high reactivity, this substance is used in several chemical syntheses, in the present case being used for production of the insecticide carbaryl. MIC has an extremely irritating effect on mucous membrane and has high acute toxicity when inhaled. The threshold concentration is at about 5 mg/m3 (2 ppm) and a concentration of 50 mg/m3 is intolerable. Symptoms accompanying exposure to MIC are coughing, increased saliva production, tear flow and difficulty in keeping the eyes open (cf. tear gas). At higher concentrations, there are difficulties in breathing, with pressure over the chest and pain when inhaling. Exposure to extremely high concentrations may lead to pulmonary oedema. At Bhopal, reduced lung capacity was noted in 40 000 people as long as three months after the accident. MIC also has an irritating effect on moist skin and may cause injury to the cornea of the eye. Isocyanates are substances leading to sensitization, i.e., people can become excessively sensitive to them. Repeated exposure leads to symptoms similar to asthma. The reason for the accident at Bhopal is assumed to have been that water entered the tank where about 40 m3 MIC was stored. This depended on a combination of the human factor and an incorrectly designed safety system. When water and MIC became mixed, a chemical reaction started with a strong heat development as a result. In due course, the safety valve of the tank burst as a result of the increase in pressure. The discharge was so violent that the coating of concrete around the tank also burst. It is probable that between 20 and 30 tonnes of MIC were released during the hour that the discharge took place. The discharge occurred from a 30 m high chimney but thisheight was entirely insufficient to reduce the effects of the discharge. The reason was the high moisture content (aerosol) in the discharge which, when evaporating, gave rise to a heavy gas which rapidly sank to the ground. The meteorological conditions were typical for a clear night with a stably stratified lower atmosphere and weak (2-3 m/s) wind with frequent changes of direction. It is this type of weather which leads to the largest consequences in situations with a continuous plume discharge. The weak wind and the weak vertical turbulence caused a slow dilution of gas and thus lead to severe effects at considerable distances. The large fluctuations in wind direction also caused large lateral movements of the gas plume. This led to a wide area being affected during the period of the discharge (about one hour). A map of the damage clearly illustrates these effects. People present within a sector of 150-180 degrees suffered severe poisoning injuries. Lethal injuries were found up to a distance of 2.5 km and severe but not lethal injuries occurred up to about a distance of 4 km. Dispersal calculations with a common risk analysis model will give also the same approximate effect with distance (1.6 and 3 km, respectively). In the calculations, it has then been assumed that 100 ppm is the lower level for lethal injuries and 30 ppm for severe injury.

Potential Chemical Weapons

An overview of some potential developments to be kept under observation

A serious long-term threat might be implied by substances which are poorly bound to active carbon. In order to pass through the filter of a protective mask, the substance must consist of small, non-polar molecules, which have high volatility. This implies that it is difficult to attain lethal concentrations in the ambient air (compare, for example, hydrogen cyanide). On the other hand, they could achieve an incapacitating effect on a small scale, e.g., in order to achieve sabotage against units that were already protected. If substances capable of penetrating modern protective masks can be dentified, then there are also opportunities to intensify research on improved protection. Thus, for example, new substances with which the filters in protective masks can be impregnated can be developed, as well as substances which better absorb or break down the new substances. If this is successful, then the threat is considerably reduced.

The borderline between BW and CW agents has started to lose importance as a result of the rapid development in biotechnology. This mainly depends on the emergence of a category of agents based on biotechnology. Biotechnology has enabled the largescale production of new types of substances. Toxic compounds of natural origin which were earlier difficult to produce, e.g., toxins and bioregulators, can now be produced in large quantities. Many of these substances exceed the toxicity of nerve agents by several orders of magnitude.

Biotechnology has also offered opportunities to produce bacteria, viruses, etc., in modified form. The gene material of microorganisms can be modified so that new bacteria or viruses are created, against which man has no immune defence. In addition, the bacteria can be changed so that they themselves can produce toxins while they multiply in the body. In comparison with pure toxin, only a very small dose of bacteria is then needed to achieve full effect. There are large opportunities to further develop weapons based on biotechnology. After studies of structure-activity relationships for certain toxins and substances produced within the body, it is possible to develop modified and even more active substances. Improved knowledge of receptors on the cell surface, for example as a result of cancer research, ill make it possible to target toxic substances to selected organs.

Weapons based on biotechnology today are probably still within the research or developmental stages. In the long-term, they may become a serious threat. Factors supporting this are that such substances:
- are active in very low concentrations,
- can cause poisoning which is difficult to diagnose and treat,
- can be completely broken down within the body,
- usually lack antidotes for medical protection and treatment,
- are difficult to detect in the environment.

Factors suggesting that their use may not arise are:
•their range of use is limited, e.g., to sabotage,
•suitable substances are rapidly broken down by the enzyme system in the gastro-intestinal tract and lungs,
•exposure via the airways can probably easily be stopped by use of respiratory protective equipment (even if this method of exposure is effective also for large molecules).

Protection Against Chemical Weapons

Introduction
•Decontamination
•Detection
•Protective Equipment
•Collective protection

Introduction

There are four main cornerstones in the protection against chemical weapons, all of which are largely dependent upon each other to provide optimum effect. These four are:

•physical protection: body protection, respiratory protection, collective protection,
•medical protection: pretreatment, therapy,
•detection: alarm, monitoring, verification, identification, all-clear,
•decontamination: individual decontamination, equipment decontamination.

In addition to this equipment, tactical behaviour suitably adapted to the CW environment is an important component in the protection. Training in how to behave in CW environment and how CW protective equipment is used is essential, not least to give the soldiers confidence in their equipment. Even though the soldiers are trained and have access to the best possible protective equipment, there will be a performance degradation once they have started to use the protective equipment. This is particularly noticeable in warm weather. Impermeable CW protective suits and also to some extent permeable suits which "respire" are very hot. During hard physicalwork, the surplus energy cannot be removed and therefore the soldier will rapidly become overheated and may suffer from heat collapse. This implies a major complication for CW protection during the summer, particularly in very hot areas such as deserts. Performance is also degraded in cooler weather. Protective equipment is relatively clumsy, which implies that most tasks require longer to perform than normal. Endurance decreases and when a protective mask is worn, it becomes difficult to

communicate with people in the neighbourhood. In tactical behaviour, contamination avoidance is essential. There may be a long delay until decontamination can be done so that the protective clothing can be removed. In addition, decontamination is time consuming. Subsequently, the permeable suits must be destroyed and new equipment made available.

Military Protection

One aim with chemical protection is to discourage an aggressor from using CW agents. In military terms this implies taking measures so that an aggressor cannot attain major military advantages. These measures depend both on the individual soldier and on the unit he belongs to, the equipment he uses, and the function he contributes to maintaining. Depending on the purpose of different protective measures, they are divided into two categories.

The first category is called the basic protection. In individual basic protection, which aims at increasing the individual's opportunities to survive, there are a protective mask, protective all-enveloping clothing, boots and gloves, as well as individual decontamination kit and medical antidotes. The basic protection associated with military units includes measures for the unit to be able to evaluate CW situations, to detect and decontaminate as well as to rescue and provide care.

The second category is mission specific protection. This implies measures for important units, systems and functions so that they can continue to work with their primary tasks to the greatest possible extent. The aim is that the defence forces will retain their operative ability even after CW attacks. Mission specific protection is adapted to the mission and thus varies between different systems and functions. This may, for example, concern collective protection in tanks and fortifications, permeable CW combat suits for turn around and repairs at an airbase, or automatic warning instrumentation on coastal corvettes. Initially, the mission specific protection is built up for functions of importance to mobilization and initial defence capacity. These will cover the central command organization as well as units and establishments considered to be exposed to early attacks in connection with aggression.

Civilian Protection

For civil defence rescue units, and also for other personnel in the civil defence with active outdoor duties, the same demands on protective equipment apply as for personnel in the armed forces. The civil defence also has a mission specific protection. However, in the case of the civilian population, the immediate problem is protection during transfer to or from a collective shelter. Consequently, the protective equipment does not need to be as advanced as corresponding equipment for personnel with direct outdoor duties. This is the reason why it is possible to use a civilian protective mask of a simpler design.

For younger children, a protective jacket can be used instead of a protective mask. Such a jacket protects the respiratory organs and alsogives some protection against CW agents in liquid form. A battery powered fan forces air through a filter and the purified air flows in front of the child's face.

Children younger than about 12 months can be given a protective "carry-cot". Slightly older children, but still too small to accept a protective jacket or a protective mask should be given some kind of collective protection.

Collective protection for civilians can be made available in shelters with filters which absorb the CW agents.

A warning system for CW agent attacks can consist both of sirens in urban areas and of warnings on the radio. The civil defence organization could equip special patrols for detection and relief in environments contaminated with CW agents. The civil defence can also have the responsibility for informing the general public when it isrisk-free to leave shelters, to air apartments, etc.

Decontamination of Chemical warfare Agents

An introduction to methods and chemicals for decontamination

- Introduction
- Decontaminants
- Decontamination methods
- Personal decontamination
- Decontamination of equipment

Introduction

In protection against chemical warfare agents the decontamination is an important unavoidable part. The aim of decontamination is to rapidly and effectively render harmless or remove poisonous substances both on personnel and equipment. High decontamination capacity is one of the factors which may reduce the effect of an attack with CW agents. In this way, it may act as a deterrent. The need for decontamination should be minimized to the extent possible by contamination avoidance and early warning. Equipment can be covered, for example, or easily decontaminated equipment can be chosen by means of suitable design and resistant surface cover. Decontamination is time consuming and requires resources. Nerve agents and substances causing injury to the skin and tissue are easily soluble in, and penetrate many different types of material, such as paint, plastics and rubber, all of which renders decontamination more difficult. If CW agents have penetrated sufficiently deep, then toxic gases can be released from the material for long periods. By adding substances which increase the viscosity of a CW agent, its persistence time and adhesive ability can be increased. These thickened agents will thus be more difficult to decontaminate with liquid decontaminants since they adhere to the material and are difficult to dissolve.

Good body and respiration protection is essential for the maintenance of operational capacity for a limited period after a CW attack. If the aggressor has used persistent substances, the unit generally must be decontaminated when regrouping or reorganizing. The need for decontamination can only be established by means of detection. If detection is not possible, then decontamination must be done solely on suspicion of contamination, e.g., if the unit has passed on the fringe of a contaminated area.

Decontaminants

All decontamination is based on one or more of the following principles:

- to destroy CW agents by chemically modifying them (destruction),

•to physically remove CW agents by absorption, washing or evaporation,
•to physically screen-off the CW agent so that it causes no damage.

Most CW agents can be destroyed by means of suitable chemicals. Some chemicals are effective against practically all types of substances. However, such chemicals may be unsuitable for use in certain conditions since they corrode, etch or erode the surface. Sodium hydroxide dissolved in organic solvent breaks down most substances but should not be used in decontaminating skin other than in extreme emergencies when alternative means are not available. Decontaminants that have effect only against a certain group of substances can be an alternative in favour of a substance with general effect. The condition is that they will have a faster and better effect against the substance in question and/or a milder effect. Examples of such substances are chloramine solutions which are often used to decontaminate personnel. These have good effect against mustard agent and V-agents but are ineffective against nerveagents of G-type (sarin, soman, tabun). A water solution of soda rapidly renders nerve agents of G-type harmless but when used in connection with V-agents, it produces a final product which is almost as toxic as the original substance. This does not prevent V-agents being washed-off with a soda solution, provided a sufficient amount is used. However, the final product will always be poisonous.

The disadvantage of specifically-acting decontaminants is partly that it is necessary to know which CW agent has been used and partly that access to several different types of decontaminating substances is required.

Decontamination methods

CW agents can be washed and rinsed away, dried up, sucked up by absorbent substances, or removed by heat treatment. Water, with or without additives of detergents, soda, soap, etc., can be used, as wellas organic solvents such as fuel, paraffin and carburettor spirit. Emulsified solvents in water can be used to dissolve and wash-off CW agents from equipment.

When decontaminating by washing, consideration must be taken to the poisonous substance remaining in the decontaminant unless the CW agent has first been destroyed. The penetration ability of a CW agent can be enhanced when mixed with solvent. Today, there is an international development towards chemically resistant paints and materials, which implies that water-based methods will become moreeffective. However, the need for penetrating decontamination methods will remain for many years.

When washing with water - particularly with hot water and detergent - the CW agent will often be decomposed to some extent through hydrolysis. Detergents containing perborates are particularly effective in destroying nerve agents. Without an addition of perborates in the detergent, the hydrolysis products of V-agents may still remain toxic unless the pH is sufficiently high. Mustard agent is encapsulated by the detergent and,

consequently, the hydrolysis rate decreases in comparison with clean water. However, the low solubility of mustard agent makes it difficult to remove without the addition of detergent, but the water used will still contain undestroyed mustard agent.

Small areas of terrain, e.g., first-aid stations or gun sites, may be decontaminated by removal of the top-soil. Another alternative is to cover the soil with chlorinated lime powder (sludge), which is a decontaminant with general effect and which releases active chlorine. CW agents which have penetrated into the soil, from where they release toxic vapour, are screened-off since the gas and liquid is destroyed by the chlorinated lime. The physical screening-off of CW agents by covering them can be done in the terrain by spreading a layer of soil or gravel over the contaminated area. The effect will be improved if bleaching powder is mixed into the covering material. Another example of covering is to use special plastic foil to cover contaminated areas inside vehicles. In this way, the personnel will be protected against transfer of liquid.

Individual Decontamination

The most important decontamination measure naturally concerns the individual. If it is suspected that skin has been exposed to liquid CW agents, then it must be decontaminated immediately (within a minute). All experience confirms that the most important factor is time; the means used in decontamination are of minor importance. Good results can be obtained with such widely differing means as talcum powder, flour, soap and water, or special decontaminants. In complete decontamination, clothes and personal equipment must also be decontaminated. If clothes have been exposed to liquid contamination, then extreme care must be taken when undressing to avoid transferring CW agents to the skin. There may be particular problems when caring for injured since it may be necessary to remove their clothes by cutting them off. This must be done in such a way that the patient is not further injured through skin contact with CW agents. During subsequent treatment it is essential to ensure that the entire patient is decontaminated to avoid the risk of exposing the medical staff to the CW agents.

In most countries, a soldier's equipment includes means for individual decontamination, generelly a mixture of chlorinated lime and magnesium oxide. This decontaminant works by absorbing liquid substances and also by releasing free chlorine which has a destructive effect on CW agents. The dry powder also has good effect on thickened agents since it bakes together the sticky substance which makes it easier to remove. Personal decontaminants containing chlorinated lime have, however, an irritating effect on the skin. Consequently, comprehensive use should be followed by a bath or shower within a few hours.

Liquid personal decontaminants are common in some countries. Sodium phenolate or sodium cresolate in alcohol solution are used for individual decontamination of nerve agents. Chloramines in alcohol solution, possibly with additional substances, are

commonly used against, e.g., mustard agent. Instead of liquid individual decontaminants, it is possible to use an absorbent powder such as bentonite ("Fuller's Earth"). In the U.S.A. the wet method formerly used was replaced by a decontaminant powder based on a mixture of resins, which decompose CW agents, and an absorbent. A factor common to all individual decontaminants is that they can effectively remove CW agents on the surface of the skin. However, they have only limited ability to remove CW agents which have become absorbed by the skin, even though very superficially. CW agents that have penetrated into the skin therefore function as a reservoir which may further contribute to the poisoning also after completed decontamination. In some cases, a wet method may give a better result in decontaminating deeply penetrated agents than a dry method. Reports from France indicate that a solution of potassium permanganate gives effective destruction of CW agents on the surface of the skin and also a certain penetrating effect. There are also individual decontaminants which can simultaneously function as a protective cream for use as a prophylactic. Canada has developed a mixture of a reactive substance (potassium 2,3-butadion monoximate) in polyehylenglycol, which has both these properties. It can be applied to the skin either as a cream or with a moist tissue.

Decontamination of Equipment

Immediate decontamination of personal equipment and certain other kinds of smaller equipment is generally done with individual decontaminants. However, these substances are only capable of decontaminating liquid CW agents covering the surface. The decontamination is mainly done to prevent further penetration into the material and to decrease the risk when handling the equipment. CW agents easily penetrate different materials and into crevasses and will thus be difficultly reached by methods only designed for superficial decontamination. When a CW agent has penetrated into the surface, it is necessary to use some kind of deep-penetrating method. If such a method cannot be used, then it must be realised that the equipment cannot be used for a long period. Depending on the type of CW agent used and prevailing weather, i.e., temperature, wind velocity and precipitation (water solubility), the "self-decontamination" may take many days or even weeks. The absorption into the surface and natural chemical degradation are important factors influencing the self-econtamination period.
The diffusion and evaporation rate of CW agents from material is speeded-up considerably when heated. The Swedish decontamination tent is heated with a mixture of hot exhaust gases and air from a small jet-pulse engine. The tent is used for decontamination of lighter articles, e.g., personal equipment. The decontamination container used by the civil defence forces is a development of the tent and heated with heat-exchanged hot air from a diesel burner.

The temperature in the tent is kept at about 130 oC and in the container at 80-130 oC, depending on the type of material to be decontaminated. Decontamination time varies between two and five hours depending on the temperature.

Other methods utilizing heat are steam or hot air which is blown against the contaminated surface. Decontamination by boiling is also an effective method. The advantage in comparison with heat is that hot water hydrolyzes and renders harmless many types of CW agents. The method may be of some interest in small-scale decontamination of rubber material, e.g., protective masks.

Decontamination of CW agents which have penetrated deeply into the surface can also be done with decontaminants which are capable of penetrating the contaminated material. There are different substances with varying properties. A modern decontaminant is the German Münster emulsion which consists of calcium hypochlorite, tetrachlorethylene, emulsifier ("phase transfer" catalyst) and water. Instead of tetrachlorethylene, the more environmentally harmless xylene is sometimes used.

Decontamination of vehicles and other large objects sometimes is done with steam and suspension and/or emulsion systems. A German company has developed special equipment, C8-DADS (Direct Application Decontamination System), with which the emulsion is prepared and then dispersed onto the vehicle or the terrain.

Generally, it is an advantage to give the material an initial flushing with water before the chemical solution is added. A Swedish development of this approach is ongoing, where the intention is to spray water on, e.g., a vehicle which passes through a flushing arch. The flushing arch has several jets which are supplied with water from a powerful pump. Another type of equipment which can use water from lakes, etc., has been developed by a Norwegian firm. This is used for both flushing with cold and hot water/steam and also as a field shower.

In order to facilitate decontamination and decrease the risk when touched, the material can be painted with chemical resistant paint systems, e.g., polyurethane paint. Design of the equipment is also of major importance for ease of decontamination.

CW Protective Equipment

An overview of respiratory and body protection

IAn attack with CW agents achieves maximum effect when it is directed against an unprotected unit. However, by taking relatively simple protective measures, the injuries can be reduced considerably. In principle, it is possible to create practically complete CW protection but generally a slightly lower level is considered sufficient. If the protective level is sufficiently high, an aggressor will probably realize that a CW attack will not be cost effective. Effective CW protection requires the building-up of some kind of "barrier" around the soldier. However, the more the soldier is protected from the ambient conditions, the greater his mobility is restricted.

Personal Protection

During an attack with CW agents, the respiratory system must be protected against aerosols and gases in the air at the same time as the rest of the body must be protected against direct contact with CW agents in the form of liquid or solid particles. After the attack, the body must be protected against contact with CW agents on the ground and on equipment. In addition, the respiratory system must be protected against evaporating gas.

Protection for the Respiratory System

The level of protection provided by a protective mask or respirator against penetration of biological and chemical weapons through the respiratory system depends on:
•advance warning,
•time required to don the mask,
•ability of the filter to absorb the CW agent,
•leakage.

CW agents may reach the people on the ground already 5-10 seconds after an attack. The agents may either be in the form of liquid droplets affecting the skin or clothing, or as a cloud of gas or aerosol. Already a few breaths from such a cloud may supply an injurious or lethal dose. In cases of surprise attacks, it is therefore of vital importance to rapidly don the protective mask so that it fits tightly against the face. The best protection against surprise attacks is obtained by continuously carrying some kind of respiratory protection. A protective mask to be used for long periods must be comfortable. A solution tested in some countries is a facelet, a semi-protective mask which is supposed to be more comfortable to wear but does not provide as good protection as a normal protective mask. However, experience has shown that the facelet is not a good alternative and, consequently, efforts are made to make the conventional protective mask as comfortable as possible to wear. This can be achieved partly by making a broad and flexible sealing edge and also by reducing the

physiological load in the mask. In modern protective masks, the inhalation resistance has been reduced by decreasing the air resistance in the filter. Exhalation resistance is reduced by means of a carefully adjusted outlet valve with a large flow area. Protective masks are designed so as to reduce the dead space. Other characteristics of the new generation of protective masks are a large field of vision and very small leakage, which in turn implies high protection. Despite this, a small proportion of the wearers will still receive insufficient protection either because of diverging face shape or inability to don the mask in the best way. This proportion can be reduced by better training and education but cannot be entirely eliminated.
A device for speech communication is included in all of the new masks. The earlier solution, a speech membrane, is now being replaced by a speech horn, which is easier to manufacture. A speech horn also gives largely the same effect as a speech membrane. New material for the filter canisters, e.g., fibre-reinforced plastic, gives them better resistance to external influence. New technical solutions to the problem of combining protective mask and glasses are available, which permit correction of visual defects without degrading the protection.

A protective mask must be capable of adaptation to different face shapes and is therefore manufactured in an elastic material. Modern masks are almost always made of some kind of rubber material. If high demands are placed on a good protective ability to permeation of CW agents, it often results in the choice of halogenated butyl rubber. A demand frequently placed today on a protective mask is that it can be worn for at least 24 hours. The mask must then also permit the intake of liquids. The filter in a protective mask consists of two parts; an aerosol filter and a gas filter. The aerosol filter is built up of a layer of glass fibres where the spacing between the fibres is large in relation to the size of the particles to be filtered. Consequently, an aerosol filter of this kind does not work by screening or filtering off the particles. The particles are removed mainly when they collide with the fibres, to which they adhere. If it is a volatile substance that adheres, it may subsequently evaporate from the aerosol filter. Consequently, it is important to design a filter whereby the gas filter component is located after the aerosol filter.

The gas filter component of the protective filter consists of active carbon. Recently other adsorbants, e.g., different synthetic polymers and zeolites have been tested but none has proved as widely applicable as active carbon. Neither have any other absorbents been found to have higher uptake ability for CW agents than active carbon. Active carbon is produced by heat-treating different organic materials. A number of commonly-used materials are peat, coconut shell and coal. The material is activated byheating it together with carbon dioxide or steam to 800-1000 oC. The carbon so obtained contains numerous pores and cavities and under magnification looks rather like a face sponge. Active carbon of the type used in protective masks has a total area of 1 000 -1 500 m2 per gramme. By selecting different starting materials and conducting the activation in different ways, the active carbon obtained has different degrees of pore distribution. Carbon with large pores is the most suitable for cleaning water, whereas carbon with small pores is better for removing gas. Pore distribution

and pore size are also important for the carbon's ability to absorb water. The particle size distribution is also important and particularly for properties such as air resistance and the protective ability against different gases.
Certain low-molecular CW agents such as hydrogen cyanide and cyanogen chloride are poorly absorbed by active carbon. In order to improve protection against thesesubstances, the carbon is impregnated with metallic salts of copper, chromium and sometimes also silver. Further impregnation with organic substances also occurs, the most common additive being triethylendiamine (TEDA). Certain types of carbon-fibre based material have higher sorption capacity than normal granulated active carbon. Use of carbon fibres of this kind in a gas filter offers advantages such as lower pressure drop, smaller volume and lower weight. The degree of leakage in modern filters is maximally 0.001 per cent and, in extreme cases, the filter provides protection against at least 10 but probably up to 100 attacks before CW agents start to leak through. If the protective mask is used in a non-contaminated atmosphere the filter will gradually become loaded since it absorbs moisture and pollution from the air. Long-term use or unsuitable storage may lead to the protective ability against certain CW agents becoming deteriorated.

Protection Against CW Agents in Liquid Form

A direct CW attack not only results in gases and aerosols but also droplets of liquid which penetrate the body through the skin. Consequently, respiratory protection is insufficient and this must be complemented with body protection. The amount of substance absorbed by the skin is determined by the following factors: CW agent, the period elapsing before decontamination, the efficiency of the decontaminant, the size of the contaminated area and the type of clothing. A condition for high levels of survival after a direct attack with CW agents in liquid form is either that the entire body surface can rapidly be protected by some kind of cover, or that protection is incorporated in the uniform of the soldiers. Protection by covering serves two purposes: it is mainly designed to prevent droplets falling on bare skin but it is also designed to reduce the need of subsequent decontamination of personal equipment.

Body Protection

The oldest types of protective clothing against CW agents consists of rubber clothing which, together with gloves and boots, cover the entire body apart from that protected by the mask. Clothing of this kind is usually characterized as impermeable. This not only refers to the fact that CW agents cannot pass through the material but also the fact that perspiration released from the skin is also prevented from passing out. Consequently, to wear clothing of this kind for longer periods may be extremely uncomfortable and in hot climates the period during which protective clothing of this kind can be worn will be very short. In order to reduce the heat load, permeable clothing has been designed where a layer of finely distributed active carbon, eitherbound in polyurethane foam or as particles of carbon, is bound between two layers of textile. A layer of this kind consisting of active carbon permits water vapour

released from the body to pass through. The active carbon absorbs CW agents and thereby prevents them from passing through to the skin. This layer of carbon is never used alone but is combined with different textiles.

A CW combat suit is an example of clothing made of permeable material. It is often designed in the same way as a battle dress. The largest difference is that inside the impregnated outer material there is a layer of active carbon on a suitable carrier. The CW combat suit can be used instead of a battle dress or as an overall placed over the uniform. An alternative is to use inner clothing with a layer of carbon which is worn underneath the normal uniform. It is impossible to conduct warfare for longer periods outdoors in CW environment without having access to CW combat suits. Impermeable suits will also in the future be used in severely contaminated environments, e.g., during decontamination. The heat load can be reduced by ventilating the clothing with fans. However, this solution is too vulnerable to be used for soldiers in combat. In order to achieve shortterm CW protection, it is possible to use overalls made of different plastic material, e.g., the C-Cover dress.

Development of Protective Masks

The historical development of military protective masks or respirators may be roughly characterized as four different generations:

1. The First World War. The first primitive masks were quickly developed after the initial use of CW agents during the First World War. The illustration shows an American mask from 1918. The basic frame of the mask is made of leather.
2. The Second World War. The protective capability was greatly improved during the period between the wars when natural rubber was used to make the basic frame of the mask. The elastic rubber material allowed the mask to better adapt itself to different shaped faces.
3. After the Second World War and up to about 1980. In about 1950, there was a more general trend to equip the mask with an inner mask. This must be regarded as a technical break-through. The inner mask solved the problem with misting of the visors also in low winter temperatures.
4. The current generation of protective masks. During the 1980's and 1990's, protective masks were improved in many ways, as regards for example comfort, fit and the intake of liquids. It might therefore be justified to regard them as the fourth generation of protective masks.

Control of Air Flow in a Protective Mask

The inhalation air is first purified during passage through the filter. The air that has passed through the filter is relatively dry. It is guided up over the visors in order to prevent them from misting. The flow of air then passes through the inner mask and then into the lungs. The exhaled air flows directly from the inner mask through the

exhalation valve. The control of the air flow is achieved by valves. A well-functioning inhalation valve is essential for the function of the mask. It must allow air to pass in through the filter but must also prevent the exhaled air from passing out through thefilter. During the inhalation phase, the exhalation valve must be fully closed and thereby prevent contaminated ambient air from entering the mask by that route. The task of the inner mask is to prevent the exhaled air from filling up the entire volume inside the mask. In this way, the moist exhaled air is prevented from passing over the visors which might cause troublesome condensation. The inner mask is usually fitted with valves to control the air flow. However, it is fully possible to design a functional inner mask without any valves.

Fitting Protective Masks

A measure of the protective ability of a mask is given by the total inward leakage. This consists of the sum of the leakage in the filter, the leakage through the fit, leakage through the exhalation valve and any other leakage. Instead, the protection factor of the mask is frequently given: Protection factor = (Concentration of a contaminant in the ambient air) / (Concentration of the same contaminant inside the mask) The protection factor states how much lower the concentration of a pollutant in the air is inside the mask in comparison with the concentration in the ambient air. Laboratory tests with a non-hazardous test substance can easily determine protection factors up to 100 000. In the field, tear gas can be used as a test substance to obtain a rough measure of the protective ability of a mask. The sensitivity in tests with tear gas (CS) is, however, not larger than that it corresponds to a protection factor somewhere in the range between 1 000 and 10 000. Even in a modern mask with a good sealing edge, the fit will start to deteriorate already when the soldier has a 24 h-old beard stubble. The protection will deteriorate with the length of the stubble. Whole beards usually result in very poor protection.

Penetration and Permeation

Two special terms are used with regard to protective clothing, penetration and permeation. Penetration implies that gases or liquids pass through seams or holes, etc. in a protective suit (non-molecular passage). Permeation implies that gases or liquids diffuse through the material, e.g., rubber, in a protective suit (molecular passage).

Dispersal of Chemical Warfare Agents

Influence of weather, terrain and buildings
In the dispersal of CW agents, a mixture of liquid droplets and gas is generated. The largest droplets fall and cause ground contamination whereas the very small droplets remain suspended as an aerosol. Together, the aerosol and the gas form a primary cloud which drifts in the wind. Evaporation of ground contamination causes a secondary cloud which also drifts in the wind.

The ratio between the primary cloud and ground contamination will be different depending on the CW agent dispersed. Addition of thickeners, the dispersal method used, and the height of the dispersal will also influence distribution. A volatile substance will cause, e.g., a large proportion of primary cloud whereas a persistentsubstance leads to more ground contamination. Explosive dispersal will lead to a greater proportion of primary cloud than if the substance is dispersed by means of spray or discharged in bulk.

Influence of Weather

An attack with chemical weapons always causes injuries to unprotected people who are in or close to the target area. Strong wind, heavy rain or temperatures below 0 oC may reduce effects. After the attack, the weather will be of great importance for the respiratory risks expected at different distances from the target. Similarly, weather conditions influence the effect of ground contamination. After an attack, the primary cloud will drift with the wind. Wind velocity will be decisive for how long it will take for the primary cloud to pass the given place. High wind velocity implies a short time of passage and thus fewer injuries to unprotected persons, whereas low wind velocity will lead to more injuries. Consequently, a weak wind may cause effects at greater distances than strong winds. Wind velocity also naturally influences how fast the primary cloud moves. If the wind is gentle, then there are better opportunities to provide warning in time. In very weak winds, however, the gas cloud will not move very far. In addition, the wind direction varies widely in such situations which is why a circular area must be alerted in an attack with CW agents.

The gas/aerosol concentration in the primary cloud also depends to a high degree on the air exchange or turbulence of the atmosphere. In clear weather during the night, the ground surface is cooled and inversion is formed (stable temperature stratification). Inversion leads to weak turbulence and thus high concentration and great effect from the primary cloud. When the sun shines during the summer, the ground surface becomes warm, with considerable turbulence as a result (unstable temperature stratification). The effect of the primary cloud is then reduced strongly, particularly at long distances. Injury caused by the primary cloud at different wind velocities and dispersal conditions. Smoke dispersal at different temperature stratifications. The concentration in the primary cloud may also decrease in cold weather and particularly if the temperature is lower than -20 oC. This depends on a smaller amount of CW

agents evaporating during dispersal which also implies that the share of ground contamination will be greater. Precipitation also reduces the concentration since some of the gas/aerosol is "washed" away by wet deposition.

Low temperature implies that ground contamination will remain and cause risks of contact for long periods. In very low temperatures, however, the effect of some substances may cease since they will freeze (freezing-point for hydrogen cyanide -13 oC, VX -39 oC, mustard agent-lewisite ca. -35 oC, soman -42 oC). Thick winter clothing will give better protection than summer clothing. A major problem during the winter may be that contaminated snow on shoes and clothes is taken into tents, vehicles or buildings. Once in the warmth, the CW agent will evaporate and may cause dangerously high concentrations of gas.

Light rain will cause ground contamination to be more dangerous since the pores in the soil become clogged and prevent the substance from penetrating down into the soil. Heavy rain, however, will flush off ground contamination whereas heavy snow will cover it. In both cases, the contact risk is decreased.

There is frequently a residue of CW agents which have penetrated the soil after the above-mentioned periods. In experiments, residues have been found after three times longer than listed. Consequently, respiration risks may still be present within the target area since the substance in the soil evaporates slowly. In situations of longer stays and activities implying close contact with the soil for longer periods, then the contact risks may remain for the longer period.

Terrain and Buildings

Woodland and undulating terrain give shorter danger distances for the primary cloud since the wind will be exposed to greater turbulence. Woodland also adsorbs a certain amount of gas and aerosol through dry deposition. In or close to the target area, however, woodland, depressions, pits and narrow streets may lengthen the effect of an attack. Gas and aerosol will be retained in these areas, particularly in situations of weak wind and stable stratification. The longest danger distances are obtained if the cloud passes over plains or lakes, or follows the contours of a valley.

The effect of a passing cloud of gas/aerosol will be delayed inside tents, buildings and vehicles. Owing to the lower air exchange in such places, it will take longer for the cloud to penetrate. A certain amount of the CW agent will be taken up and bound on walls and other surfaces, which also contributes to decreases in concentration. Consequently, it may be expected that there is a certain reduction in the effect of a passing cloud of gas. In ordinary buildings, the protection can be improved by closing doors and windows, turning off the ventilation and sealing all cracks with tape.
It will, thus, take longer for the cloud of gas to penetrate a house, for example. For the same reason, the gas will remain longer in-doors when the rest of the cloud has passed by. Consequently, it is of the greatest importance to obtain information on

when it is possible to start airing the building again.

Ground configuration is also of importance for the contact risk in ground contamination. A dry, hard but porous surface, e.g., asphalt or concrete, will lead to fewer contact risks. On soft ground, e.g., grass, moss, sand or snow, it is easier to come into contact with CW agents which have penetrated the underlying surface. In dense woodland, the ground contamination is reduced and becomes uneven since the falling droplets are caught to some extent in the crowns of the trees. Terrain covered by bushes, on the other hand, may lead to major risks of contact.

Influence of Weather on the Primary Cloud

Factors diminishing the danger of the primary cloud:
•Variable wind direction
•Wind velocity > 6 m/s
•Unstable air (turbulence)
•Temperature < 0 oC
•Occurrence of precipitation

Factors increasing the danger of the primary cloud
•Steady wind direction
•Wind velocity < 3 m/s
•Stable air (inversion)
•Temperature > 20 oC
•High humidity (in case of mustard agent)
•No precipitation

Influence of Weather on Ground Contamination

Factors decreasing the danger of ground contamination
•High ground temperature (but light clothes provide less protection)
•High wind velocity
•Unstable air
•Heavy precipitation

Factors increasing the danger of ground contamination
•Temperature below 0 oC but above the freezing point of the contamination
•Low wind velocity
•Stable air (inversion)
•Very light rain

LETHAL NERVE AGENT (GB)

SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996
MANUFACTURER'S ADDRESS:
U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423
Emergency telephone #' s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer
CAS REGISTRY NUMBERS: 107-44-8, 50642-23-4
CHEMICAL NAME:
Isopropyl methylphosphonofluoridate

ALTERNATE CHEMICAL NAMES:
O-Isopropyl Methylphosphonofluoridate
Phosphonofluoridic acid, methyl-, isopropyl ester
Phosphonofluoridic acid, methyl-, 1-methylethyl ester

TRADE NAME AND SYNONYMS:
Isopropyl ester of methylphosphonofluoridic acid
Methylisopropoxfluorophosphine oxide
Isopropyl Methylfluorophosphonate
O-Isopropyl Methylisopropoxfluorophosphine oxide
Methylfluorophosphonic acid, isopropyl ester
Isopropoxymethylphosphonyl fluoride
Isopropyl methylfluorophosphate
Isopropoxymethylphosphoryl fluoride
GB
Sarin
Zarin

CHEMICAL FAMILY: Fluorinated organophosphorous compound
FORMULA/CHEMICAL STRUCTURE:
$C_4H_{10}FO_2P$

NFPA 704 HAZARD SIGNAL:
Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS NAME FORMULA PERCENTAGE BY WEIGHT AIRBORNE EXPOSURE LIMIT
(AEL) GBC4H10FO2P1000.0001 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT: 158 C (316 F)
VAPOR PRESSURE (mm Hg): 2.9 @ 25 C
VAPOR DENSITY (AIR=1): 4.86
SOLUBILITY: Miscible with water. Soluble in all organic solvents.
SPECIFIC GRAVITY (H2O=1): 1.0887 @ 25 C
FREEZING/MELTING POINT: -56 C
LIQUID DENSITY (g/cc):
1.0887 @ 25 C
1.102 @ 20 C
PERCENTAGE VOLATILE BY VOLUME:
22.000 m/m3 @ 25 C
16.090 m/m3 @ 20 C
APPEARANCE AND ODOR: Colorless liquid. Odorless in pure form.

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (METHOD USED): Did not flash to 280 F
FLAMMABLE LIMIT: Not applicable
LOWER EXPLOSIVE LIMIT: Not available
UPPER EXPLOSIVE LIMIT: Not available
EXTINGUISHING MEDIA: Water mist, fog, foam, CO2.
Avoid using extinguishing methods that will cause splashing or spreading of the GB.
SPECIAL FIRE FIGHTING PROCEDURES: GB will react with steam or water to produce toxic and corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GB should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighting protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to

a
chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (See Section VIII). Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen may be present.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for GB for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.0001 mg/m3. This value is based on the TWA of GB which can be found in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GB.GB is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.
EFFECTS OF OVEREXPOSURE: GB is a lethal cholinesterase inhibitor. Doses that are potentially life threatening may be only slightly larger than those producing least effects.

GB Route Dosage
ocular
inhalation
inhalation (15 1/min)
inhalation
percutaneous Form
vapor
vapor
vapor
vapor
liquid Effect
ECt50
ECt50
ICt50
LCt50
LD50 Type
<2 mg-min/m3
<2 mg-min/m3
35 mg-min/m3

70 mg-min/m3
1700 mg/70 kg man
Effective dosages for vapor are estimated for exposure durations of 2-10 minutes. Symptoms of overexposure may occur within minutes or hours, depending upon dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking and sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and respiratory failure.

EMERGENCY AND FIRST AID PROCEDURES:
INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag oroxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.
EYE CONTACT: Immediately flush eyes with water for at least 15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to a medical treatment facility for observation.
SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove decontaminant. Administer Nerve Agent Antidote Kit(s), MARK I injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.
INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. IMMEDIATELY administer Nerve Agent Antidote Kit(s), MARK I injector(s). Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable when pure.
INCOMPATIBILITY: Attacks tin, magnesium, cadmium plated steel, and some aluminum. Slightly attacks copper, brass, and lead; practically no attack on 1020

steels, Inconel & K-monel.
HAZARDOUS DECOMPOSITION: Hydrolyzes to form HF under acid conditions and isopropyl alcohol & polymers under basic conditions.
HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leaks or spills occur, only personnel in full protective clothing will remain in area (See Section VIII). In case of personnel contamination see Section V for emergency and first aid instructions.
RECOMMENDED FIELD PROCEDURES: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous sodium hydroxide solution (a minimum 10 wt. %). Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and then labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).If 10 wt.% aqueous sodium hydroxide solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent, DS (DS2), Sodium Carbonate, and Supertropical Bleach Slurry (STB).
RECOMMENDED LABORATORY PROCEDURES: A minimum of 56 grams of decon solution is required for each gram of GB. Decontaminant and agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour. At the end of the hour, the resulting solution should be adjusted to a pH greater than 11.5. If the pH is below 11.5, NaOH should be added until a pH above 11.5 can be maintained for 60 minutes. An alternate solution for the decontamination of GB is 10 wt.% sodium carbonate in place of the 10% sodium hydroxide solution above. Continue with 56 grams of decon for each gram of agent. Agitate for one hour but allow three hours for the reaction. The final pH should be adjusted to above zero. It is also permitted to substitute 5.25% sodium hypochlorite or 25 wt. % Monoethylamine (MEA) for the 10% sodium hydroxide solution above. MEA must be completely dissolved in water before addition of the agent. Continue with 56 grams of decon for each gram of GB and provide agitation for one hour. Continue with same ratios and time stipulations. Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and then labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite

placedbetween the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).
WASTE DISPOSAL METHOD: Open pit burning or burying of GB or items containing or contaminated with GB in any quantity is prohibited. The detoxified GB (using procedures above) can be thermally destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, state and local Resource Conservation and Recovery Act (RCRA) Regulations.
NOTE: Some states define decontaminated surety material as an RCRA Hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:
CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT. <0.0001 mg/m3A full face piece, chemical canister, air purifying protective mask will be on hand for escape. (The M9-, M17-, or M40-series masks areacceptable for this purpose. Other masks certified as equivalent may be used) > 0.0001 or =0.2 mg/m3A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators withescape air cylinder may be used.Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA PAM 385-61 for determination of appropriate level) >0.2 or unknownmg/m3NIOSH/MSHA approved pressure demand fullf ace piece SCBA suitable for use in high agent concentrations with protective ensemble (See DAPAM 385-61 for examples)
VENTILATION:
Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to < 0.0001 mg/m3. Air emissions will meet local, state and federal regulations.
Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in the assessment of the hoods ability to contain agent GB.
Other: Recirculation of exhaust air from agent areas is prohibited. No connection is allowed between agent areas and other areas through the ventilation system. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.
PROTECTIVE GLOVES:
Butyl Rubber Glove M3 and M4

Norton, Chemical Protective Glove Set
EYE PROTECTION: As a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.
OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat will be worn with mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.
MONITORING: Available monitoring equipment for agent GB is the M8/M9 Detector paper, detector ticket, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automatic Continuous Air Monitoring System (ACAMS), real time monitoring (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission Detector (HYFED), CAM-M1, Miniature Chemical Agent Monitor (MINICAM) and the Real Time Analytical Platform (RTAP). Real-time, low-level monitors (with alarm) are required for GB operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agents are permitted. Containers should be periodically inspected for leaks either visually or by a detector kit). Stringent control over all personnel practices must be exercised Decontamination equipment will be conveniently located. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the work day.
OTHER PRECAUTIONS: GB must be double contained in liquid and vapor tight containers when in storage or outside a ventilation hood.For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.
DOT HAZARD CLASSIFICATION: 6.1, Packing Group I,Hazard Zone A
DOT LABEL: Poison
DOT MARKING: Poisonous liquid, n.o.s. (Isopropyl methylphosphonofluoridate) UN2810, Inhalation Hazard

DOT PLACARD: Poison
EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and
VIII.
PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of this data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

LETHAL NERVE AGENT (GD)

SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996
MANUFACTURER'S ADDRESS:
U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423
Emergency telephone #' s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer
CAS REGISTRY NUMBERS: 96-64-0, 50642-24-5
CHEMICAL NAME:
Pinacolyl methyl phosphonofluoridate
ALTERNATE CHEMICAL NAMES:
Phosphonofluoridic acid, methyl-,1,2,2-trimethylpropyl ester
O-Pinalcolyl methylphosphonofluoridate
TRADE NAME AND SYNONYMS:
3,3 dimethyl-n-but-2-yl methylphosphonofluridate
1,2,2-Trimethylpropyl methylphosphonofluoridate
Methylpinacolyloxyfluorophosphine oxide
Pinacolyloxymethylphosphonyl fluoride
Pinacolyl methanefluorophosphonate
Methylfluoropinacolylphosphonate
Fluoromethylpinacolyloxyphosphine oxide
Methylpinacolyloxyphosphonyl fluoride
Pinacolyl methylfluorophosphonate
1,2,2-Trimethylpropoxyfluoromethylphosphine oxide
GD
EA 1210
Soman
Zoman
PFMP
CHEMICAL FAMILY: Fluorinated organophosphorous compound
FORMULA/CHEMICAL STRUCTURE:
$C_7H_{16}FO_2P$
NFPA 704 SIGNAL:
Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS NAME FORMULA PERCENTAGE BY WEIGHT AIRBORNE EXPOSURE LIMIT
(AEL) GDC7H16FO2P1000.00003 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT: 198 C (388 F)
VAPOR PRESSURE: 0.40 mm Hg @ 25 C
VAPOR DENSITY (AIR=1): 6.33
SOLUBILITY: 2.1 percent at 20 C and 3.4 percent at 0 C in water. Soluble in sulfur mustard, gasoline, alcohols, fats, and oils.
SPECIFIC GRAVITY (H2O=1): 1.022 @ 25 C
FREEZING/MELTING POINT: -42C
LIQUID DENSITY (g/cc): 1.0222 @ 25 C
PERCENTAGE VOLATILE BY VOLUME: 3900 mg/m3 @ 25 C
APPEARANCE AND ODOR: When pure, colorless liquid with a fruity odor. With impurities, amber or dark brown with oil of camphor odor.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: 121 C (Open cup)
FLAMMABLE LIMIT: Unknown
LOWER EXPLOSIVE LIMIT: Not available
UPPER EXPLOSIVE LIMIT: Not available
EXTINGUISHING MEDIA: Water mist, fog, foam, CO2. Avoid using extinguishing methods that will cause splashing or spreading of the GD.
SPECIAL FIRE FIGHTING PROCEDURES: GD will react with steam or water to produce toxic & corrosive vapors. All persons not engaged in extinguishing the fire should be evacuated. Fires involving GD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighting protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (See Section VIII).
Do not breathe fumes. Skin contact with nerve agents must be avoided at

all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.
UNUSUAL FIRE AND EXPLOSION HAZARDS: Hydrogen produced by the corrosive vapors reacting with metals, concrete, etc., may be present.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for GD for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.00003 mg/m3. This value is based on the TWA of GD which can be found in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for GD.
GD is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.
EFFECTS OF OVEREXPOSURE: GD is a lethal cholinesterase inhibitor. Doses that are potentially life threatening may be only slightly larger than those producing least effects.
GD
Route
ocular
inhalation
inhalation (15 1/min)
inhalation (15 1/min)
percutaneous Form
vapor
vapor
vapor
vapor
liquid Effect
miosis
runny nose
severe incapacitation
death
death Type
ECt50
ECt50
ICt50

LCt50
LD50 Dosage
<2 mg-min/m3
<2 mg-min/m3
35 mg-min/m3
70 mg-min/m3
350 mg/70 kg man
Effective dosages for vapor are estimated for exposure durations of 2-10minutes.
Symptoms of overexposure may occur within minutes or hours, depending upon dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking and sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and respiratory failure.
EMERGENCY AND FIRST AID PROCEDURES:
INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.
EYE CONTACT: Immediately flush eyes with water for at least 15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to a medical treatment facility for observation.
SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove
decontaminant. Administer Nerve Agent Antidote Kit(s), MARK I injectors only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal.
IMMEDIATELY administer Nerve Agent Antidote Kit(s), MARK I injector(s).
Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable after storage in steel for three months at 65 C.
INCOMPATIBILITY: GD corrodes steel at the rate of 1 x 10-5 inch/month.
HAZARDOUS DECOMPOSITION: GD will hydrolyze to form HF and

HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK AND DISPOSAL METHODS

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leak or spills occur, only personnel in full protective clothing (See Section VIII) will remain in area. In case of personnel contamination see Section V for emergency and first aid instructions.
RECOMMENDED FIELD PROCEDURES: Spills must be contained by covering with vermiculite, diatomaceous earth, clay, fine sand, sponges, and paper or cloth towels. Decontaminate with copious amounts of aqueous Sodium Hydroxide solution (a minimum 10 wt.%). Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and then labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).
If 10 wt.% aqueous sodium hydroxide solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent, DS (DS2), Sodium Carbonate, and Supertropical Bleach Slurry (STB).
RECOMMENDED LABORATORY PROCEDURES: A minimum of 55 grams of decon solution is required per gram of GD. Decontaminant/agent solution is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour provided a single phase is obtained. At the end of the first hour the pH should be checked and adjusted up to 11.5 with

additional NaOH as required. An alternate solution for the decontamination of GD is 10% sodium carbonate in place of the 10% Sodium Hydroxide solution above. Continue with 55 grams of decon per gram of GD. Agitate for one hour and allow to react for three hours. At the end of the third hour adjust the pH to above 10. It is also permitted to substitute 5.25 % sodium hypochlorite for the 10% sodium hydroxide solution above. Continue with 55 grams of decon per gram of GD. Agitate for one hour and allow to react for three hours then adjust the pH to above 10. Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (See Sections II and VIII).

WASTE DISPOSAL METHOD: Open pit burning or burying of GD or items containing or contaminated with GD in any quantity is prohibited. The detoxified GD (using procedures above) can be thermally destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, state and local Resource Conservation and Recovery Act (RCRA) regulations.

NOTE: Some states define decontaminated surety material as a RCRA Hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:

CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT <0.00003 mg/m3A full face
piece, chemical canister, air-purifying
protective mask will be on hand for escape.
(The M9-, M17-, or M40-series masks are
acceptable for this purpose. Other masks
certified as equivalent may be used). >0.00003 to 0.06 mg/m3A NIOSH/MSHA approved pressure demand full
face piece SCBA or supplied air respirators with
escape air cylinder may be used. Alternatively, a
full face piece, chemical canister air-purifying
protective mask is acceptable for this purpose
(See DA PAM 385-61for determination of appropriate

level) 0.06 mg/m3 or unknownNIOSH/MSHA approved pressure demand full f ace piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA PAM 385-61 for examples). VENTILATION:
Local Exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to < 0.0001 mg/m3. Air emissions will meet local, state and federal regulations.
Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in the assessment of the hood's ability to contain agent GD.
Other: Recirculation of exhaust air from agent areas is prohibited. No connection is allowed between agent areas and other areas through the ventilation systems. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.

PROTECTIVE GLOVES:
Butyl Rubber Glove M3 and M4
Norton, Chemical Protective Glove Set
EYE PROTECTION: As a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.
OTHER PROTECTIVE EQUIPMENT: For general lab work, gloves and lab coat will be worn with mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.
MONITORING: Available monitoring equipment for agent GD is the M8/M9 Detector paper, detector ticket, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAAMS), Automatic Continuous Air Monitoring System (ACAMS), real time monitoring (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A2, Hydrogen Flame Photometric Emission Detector (HYFED), CAM-M1, Miniature Chemical Agent Monitor (MINICAM) and the Real Time Analytical Platform (RTAP).
Real-time, low-level monitors (with alarm) are required for GD operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating and drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the work day.
OTHER PRECAUTIONS: GD must be double contained in liquid and vapor tight containers when in storage or when outside a ventilation hood.
For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety
Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.
DOT HAZARD CLASSIFICATION: 6.1, Packing Group I, Hazard Zone B
DOT LABEL: Poison
DOT MARKING: Poisonous liquids, n.o.s. (Pinacolyl methyl phosphonofluoridate)
UN 2810, Inhalation Hazard
DOT PLACARD: POISON img align=top src="/RDA/erdec/risk/safety/graphics/dot_pois.gif" hspace=100 vspace=0>
EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and
VIII.

PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center,

Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of this data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws regulations.

ADDENDUM A: ADDITIONAL INFORMATION FOR THICKENED GD

TRADE NAME AND SYNONYMS: Thickened GD, TGD.
HAZARDOUS INGREDIENTS: K125 (an acryloid copolymer, 5%) is used to thicken the GD. K125 is not known to be a hazardous material except in a finely-divided, powder form.
PHYSICAL DATA: Essentially the same as GD except for viscosity. The viscosity of TGD is approximately 1180 centistoke.
FIRE AND EXPLOSION DATA: Same as GD.
HEALTH HAZARD DATA: Same as GD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing. Immediately scrape the TGD from the skin surface, then wash the contaminated surface with acetone. Administer Nerve Agent Antidote Kit, MARK I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY.
SPILL, LEAK AND DISPOSAL PROCEDURES: If spills or leaks of TGD occur, follow the same procedure as those for GD, but add the following step: Since TGD is not water soluble, dissolve the TGD in acetone before introducing any decontaminating solution. Containment of TGD is generally not necessary. Spilled TGD can be carefully scraped off the contaminated surface and placed in a DOT approved container. The TGD can then be decontaminated after it has been dissolved in acetone, using the same procedures as for GD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as for GD.
SPECIAL PROTECTION INFORMATION: Same as GD.
SPECIAL PRECAUTIONS: Same as GD with the following addition: Handling the TGD requires careful observation of the "stringers" (elastic, thread like attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.
TRANSPORTATION DATA: Same as GD.

LEWISITE

SECTION I - GENERAL INFORMATION

DATE: 16 April 1988
REVISED: 27 March 1996
MANUFACTURER'S ADDRESS:
U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND EDGEWOOD RESEARCH
DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423
Emergency telephone #' s: 0700-1630 EST: 410-671-4411/4
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer
CAS REGISTRY NUMBER: 541-25-3
CHEMICAL NAME:
Dichloro-(2-chlorovinyl) arsine

TRADE NAME AND SYNONYMS:
Arsine, (2-chlorovinyl) dichloro-
Arsonous dichloride, (2-chloroethenyl)
Chlorovinylarsine dichloride
2-Chlorovinyldichloroarsine
Beta-Chlorovinyldichloroarsine
Lewisite
L
EA 1034
CHEMICAL FAMILY: Arsenical (vesicant)
FORMULA/CHEMICAL STRUCTURE: C2H2AsC13

NFPA 704 HAZARD SIGNAL:
Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS NAME FORMULA PERCENTAGE BY WEIGHT AIRBORNE EXPOSURE LIMIT
(AEL) LewisiteC2H2AsCl3100* 0.003 mg/m3 * This is a ceiling value

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SECTION III - PHYSICAL DATA

BOILING POINT: 374 F 190 C
VAPOR PRESSURE (mm Hg):
0.35 @ 25 C
0.394 @ 20 C
VAPOR DENSITY (AIR=1): 7.1
SOLUBILITY: Insoluble in water and dilute mineral acids. Soluble in organic solvents, oils. and alcohol.
SPECIFIC GRAVITY (H2O=1): 1.88 @ 25 C
FREEZING POINT: 18 C to 0.1 C depending on purity
VOLATILITY: 4,480 mg/m3 @ 20 C
MOLECULAR WEIGHT: 207.32
LIQUID DENSITY: 1.89 at 20 C (Much heavier than Mustard)
APPEARANCE AND ODOR: Pure L is a colorless oily liquid. "War gas" is an amber to dark brown liquid. A characteristic odor is usually geranium-like; very little odor when pure.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT (Method Used): Does not flash
FLAMMABILITY LIMITS: N/A.
EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will cause splashing or spreading of L.
SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be evacuated immediately. Fires involving L should be contained to prevent contamination of uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (Without Tap Clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI)operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes, they will wear appropriate levels of protective clothing (See Section VIII).
Do not breathe fumes. Skin contact with agents must be avoided always. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration of L for an 8-hour workday or a 40-hour work week is an 8-hour time weighted average (TWA) of 0.003 mg/m3 as a ceiling value. A ceiling value may not be exceeded anytime. The ceiling value for Lewisite is based upon the present technologically feasible detection limits of 0.003 mg/m3. This value can be found in "DA Pam 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard H, HD, HT, and L." To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated permissible exposure concentration for L.

EFFECTS OF OVEREXPOSURE: L is a vesicant (blister agent), also, it acts as a systemic poison, causing pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure. In order of severity and appearance of symptoms, it is: a blister agent, a toxic lung irritant, absorbed in tissues, and a systemic poison. When inhaled in high concentrations, may be fatal in as short a time as 10 minutes. L is not detoxified by the body. Common routes of entry into the body include ocular, percutaneous, and inhalation.

TOXICOLOGICAL DATA:

Man:

LCt50 (inhalation, man) = 1200 - 1500 mg min/m3

LCt50 (skin vapor exposure, man) = 100,000 mg min/m3 LDLO (skin, human) = 20 mg/kg

LCt50 (skin, man): >1500 mg/min3. L irritates eyes and skin and gives warning of its presence. Minimum effective dose (ED min) = 200 mg/m3 (30 min).

ICt50 (eyes, man): <300 mg min/m3.

Animal:

LD50 (oral, rat) = 50 mg/kg

LD50 (subcutaneous, rat) = 1 mg/kg

LCtLO (inhalation, mouse) = 150 mg/m3 10m

LD50 (skin, dog = 15 mg/kg RTECS) or 38 mg/kg (ERDEC chemical agent data sheets)

LD50 (skin, rabbit) = 6 mg/kg

LD50 (subcutaneous, rabbit) = 2 mg/kg

LD50 (intravenous, rabbit) = 500 mg/kg

LD50 (skin, guineapig) = 12 mg/kg

LD50 (subcutaneous, guinea pig) = 1 mg/kg

LD50 (skin, domestic farm animals) = 15 mg/kg

LCt50 (inhalation, rat) = 1500 mg min/m3 (9 min)

LCt50 (vapor skin, rat) = 20,000 mg min m 25 min)

LCD50 (skin, rat) = 15 - 24 mg/kg
LD50 (ip, dog) = 2 mg/kg
EDmin (skin, dog) = 50 mg/m3 (30 min)
EDmin (eye, dog) = 20 mg/m3 (30 min)
EDmin (skin, rabbit) = 25 mg/m3 (30 min)
EDmin (eye, rabbit) = 1 mg/m3 (30 min)
ACUTE EXPOSURE:
EYES: Severe damage. Instant pain, conjunctivitis and blepharospasm leading to closure of eyelids, followed by corneal scarring and iritis. Mild exposure produces reversible eye damage if decontaminated instantly. More permanent injury or blindness is possible within one minute of exposure.
SKIN: Immediate stinging pain increasing in severity with time. Erythema (skin reddening) appears within 30 minutes after exposure accompanied by pain with itching and irritation for 24 hours. Blisters appear within 12 hours after exposure with more pain that diminished after 2-3 days. Skin burns are much deeper than with HD. Tender skin, mucous membrane, and perspiration covered skin are more sensitive to the effects of lewisite. This, however, is counteracted by L's hydrolysis by moisture, producing less vesicant, higher vapor pressure product.
RESPIRATORY TRACT: Irritating to nasal passages and produces a burning sensation followed by profuse nasal secretion and violent sneezing. Prolonged exposure causes coughing and production of large quantities of froth mucus. In experimental animals, injury to respiratory tracts, due to vapor exposure is similar to mustard's; however, edema of the lung is more marked and frequently accompanied by pleural fluid.
SYSTEMIC EFFECTS: L on the skin, and inhaled vapor may cause systemic poisoning. A manifestation of this is a change in capillary permeability, which permit's loss of sufficient fluid from the bloodstream to cause hemoconcentration, shock and death. In nonfatal cases, hemolysis of erythrocytes has occurred with a resultant hemolytic anemia. The excretion of oxidized products into the bile by the liver produces focal necrosis of that organ, necrosis of the mucosa of the biliary passages with periobiliary hemorrhages, and some injury to the intestinal mucosa. Acute systematic poisoning from large skin burns cause's pulmonary edema, diarrhea, restlessness, weakness, subnormal temperature, and low blood pressure in animals.
CHRONIC EXPOSURE: Lewisite can cause sensitization and chronic lung impairment. Also, by comparison to agent mustard and arsenical compounds, it can be considered as a suspected human carcinogen.
EMERGENCY AND FIRST AID PROCEDURES:
INHALATION: Hold breath until respiratory protective mask is donned. Remove from the source IMMEDIATELY. If breathing has stopped give artificial respiration. Mouth-to-mouth resuscitation should be used when approved maskbag or oxygen system are not available. Do not use

mouth-to-mouth resuscitation when facial contamination exists. Seek medical attention IMMEDIATELY.
EYE CONTACT: Speed in decontaminating the eyes is essential. Remove the person from the liquid source, flush the eyes immediately with water for at least 15 minutes tilting the head to the side, pulling eyelids apart with fingers and pouring water slowly into the eyes. Do not cover eyes with bandages, if necessary, protect eyes by means of dark or opaque goggles. Seek medical attention IMMEDIATELY.
SKIN CONTACT: Remove the victim from the source immediately and remove contaminated clothing. Immediately decon affected areas by flushing with 10% sodium carbonate solution or liquid household bleach within one minute. After 3-4 minutes, wash off with soap and water to protect against erythema. Seek medical attention IMMEDIATELY.
INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable in steel or glass containers.
INCOMPATIBILITY: Corrosive to steel at a rate of 1 x 10 -5 to 5 x 10-5 in/month at 65 C.
HAZARDOUS DECOMPOSITION PRODUCTS: Reasonably stable; however, in presence of moisture, it hydrolyses rapidly, losing its vesicant property. It also hydrolyses in acidic medium to form HC1 and non-volatile (solid) chlorovinylarsenious oxide, which is less vesicant than Lewisite. Hydrolysis in alkaline medium, as in decontamination with alcoholic caustic or carbonate solution or Decontaminating Agent, DS(DS2), produces acetylene and trisodium arsenate (Na3AS04). Therefore, decontaminated solution would contain toxic arsenic.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: Only personnel in full protective clothing (See Section VIII) will be allowed in area where L is spilled. See Section V for emergency and first aid procedures.
RECOMMENDED FIELD PROCEDURES: The L should be contained using vermiculite, diatomaceous earth, clay, or fine sand and neutralized as soon as possible using copious amounts of alcoholic caustic, carbonate, or DS2. Caution must be exercised when using these decontaminates since acetylene will be given off. Household bleach can also be used if accompanied by stirring to allow contact. Scoop up all contaminated material and clothing and place in approved DOT containers. Cover with

additional decontaminant. Decontaminate the outside of the container and label according to DOT and EPA requirements. All leaking containers will be over packed with vermiculite placed between interior and exterior containers. Decontaminate and lable according to EPA and DOT regulations. Dispose of as specified below. Dispose of decontaminate according to Federal, State, and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (See Sections II and VIII).

RECOMMENDED LABORATORY PROCEDURES: A 10 wt. % alcoholic sodium hydroxide
solution is prepared by adding 100 grams of denatured ethanol to 900 grams of 10 wt.% NaOH in water. A minimum of 200 grams of decon is required for each gram of L. The decon/agent solution is agitated for a minimum of one hour. At the end of one hour the resulting pH should be checked and adjusted to above 11.5 using additional NaOH, if required. It is permitted to substitute 10 wt.% alcoholic sodium carbonate made and used in the same ratio as the NaOH listed above. Reaction time should be increased to 3-hours with agitation for the first hour. Final pH should be adjusted to above 10. It is permitted to substitute 5.25% sodium hypochlorite for the 10% alcoholic sodium hydroxide solution above. Allow one hour with agitation for the reaction. Adjustment of the pH is not required. Scoop up all contaminated material and place in an approved DOT container. Cover with additional decontaminant. Decontaminate the outside of the container and label according to DOT and EPA requirements. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of as specified below. Dispose of the decontaminate according to Federal, state, and local regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limit (See Section VIII).

WASTE DISPOSAL METHOD: All neutralized material should be collected and contained for disposal according to land ban RCRA regulations or thermally decomposed in an EPA permitted incinerator equipped with a scrubber that will scrub out the chlorides and equipped with an electrostatic precipitator or other filter device to remove arsenic. Collect all the arsenic dust from the electrostatic precipitator or other filter device and containerize and label according to DOT and EPA regulations. The arsenic will be disposed of according to land ban RCRA regulations. Any contaminated materials or protective clothing should be decontaminated using alcoholic caustic, carbonates, or bleach analyzed to assure it is free of detectable contamination (3X) level. The clothing should then be sealed in plastic bags inside properly labeled drums and held for shipment back to the DA issue point.

NOTE: Some states define decontaminated surety material as an RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:
CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT. <0.003 mg/m3A full face
piece, chemical canister, air purifying
protective mask will be on hand for escape.
(The M9-, M17-, or M40-series masks are
acceptable for this purpose. Other masks
certified as equivalent may be used) > 0.003 mg/m3 or unknownA
NIOSH/MSHA approved, full face piece SCBA
suitable for use in high agent concentrations with
a protective ensemble. (See DA Pam 385-61) VENTILATION
Local exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to non-detectable level. Air emissions will meet local, state and federal regulations.
Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (1fpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test utilizing smoke producing devices will be performed in the assessment of the inclosure's ability to contain Lewisite.
Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hoods. Procedures should be developed for disposal of contaminated filters.
PROTECTIVE GLOVES: Norton, Chemical Protective Glove Set, Butyl Rubber Gloves M3 and M4
EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazard use goggles and face-shield.
OTHER PROTECTIVE EQUIPMENT: For laboratory operations, wear lab coats, gloves and have a mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.
MONITORING: Available monitoring equipment for agent L is the M18A2 (yellow band), bubblers (arsenic and GC method), and M256 & A1 Kits. Real-time, low-level monitors (with alarm) are required for L

operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating, or drinking in areas containing agents is permitted. Containers should be periodically inspected for leaks, either visually or using a detector kit. Stringent control over all personnel handling L must be exercised. Decontaminating equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eye wash stations, and personal cleanliness facilities must be provided. Wash hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap before leaving at the end of the workday.
OTHER PRECAUTIONS: L should be stored in containers made of glass for Research, DevelopmentTest and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent will be double contained in liquid and vapor tight containers when in storage or during transportation.
For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA Pam 385-61, Toxic Chemical Agent Safety Standards," and "DA Pam 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard H, HD, HT, and L."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.
DOT HAZARDS CLASSIFICATION: 6.1, Packing Group I
DOT LABEL: Poison
DOT MARKING: Poisonous liquids, n.o.s. Dichloro-(2-chlorovinyl)arsine UN 2810
DOT PLACARD: POISON
EMERGENCY ACCIDENT PRECAUTIONS & PROCEDURES: See Sections IV, VII and VIII.
PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted according to AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assumes legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be according to applicable Federal, State, and local laws and regulations.

LETHAL NERVE AGENT (VX)

SECTION I - GENERAL INFORMATION

DATE: 14 September 1988
REVISED: 28 February 1996
MANUFACTURER'S ADDRESS:
U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423
Emergency telephone #' s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer
CAS REGISTRY NUMBERS: 50782-69-9, 51848-47-6, 53800-40-1, 70938-84-0
CHEMICAL NAME:
O-ethyl-S-(2-iisopropylaminoethyl) methyl phosphonothiolate
TRADE NAME AND SYNONYMS:
Phosphonothioic acid, methyl-, S-(2-bis(1-methylethylamino)ethyl)
0-ethyl ester
O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothiolate
S-2-Diisopropylaminoethyl O-ethyl methylphosphonothioate
S-2((2-Diisopropylamino)ethyl) O-ethyl methylphosphonothiolate
O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate
O-ethyl S-(2-diisopropylaminoethyl) methylthiolphosphonoate
S-(2-diisopropylaminoethyl) o-ethyl methyl phosphonothiolate
Ethyl-S-dimethylaminoethyl methylphosphonothiolate
VX
EA 1701
TX60
CHEMICAL FAMILY: Sulfonated organophosphorous compound
FORMULA/CHEMICAL STRUCTURE:
C11H26NO2PS
NFPA 704 HAZARD SIGNAL:
Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS EXPOSURE FORMULAPERCENTAGE BY WEIGHT AIRBORNE EXPOSURE
LIMIT (AEL) VXC11H26NO2PS100%0.0001 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT : 298 C (568 F)
VAPOR PRESSURE (mm Hg): 0.0007 @ 20 C
VAPOR DENSITY (AIR=1): 9.2
FREEZING/MELTING POINT : Below -51 C
LIQUID DENSITY (g/cc): 1.0083 @ 20 C
PERCENTAGE VOLATILE BY VOLUME: 10.5 mg/m3 @ 25 C
SOLUBILITY: Slightly soluble in water at room temperature. Soluble in organic solvents.
APPEARANCE AND ODOR: Colorless to straw colored liquid & odorless, similar in appearance to motor oil.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT: 159 C (McCutchan - Young)
FLAMMABILITY LIMITS (% by volume): Not Available
LOWER EXPLOSIVE LIMIT: Not Applicable
UPPER EXPLOSIVE LIMIT: Not Applicable
EXTINGUISHING MEDIA: Water mist, fog, foam, CO2. Avoid using extinguishing methods that will cause splashing or spreading of the VX.
SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving VX should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing VX , fire fighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief of chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for rescue/reconnaissance purposes they will wear appropriate levels of protective clothing (See Section VIII).
Do not breathe fumes. Skin contact with nerve agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with liquid VX or vapors can be fatal.
UNUSUAL FIRE AND EXPLOSION HAZARDS: None known.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMITS (AEL): The permissible airborne exposure concentration for VX for an 8-hour workday of a 40-hour work week is an 8-hour time weighted average (TWA) of 0.00001 mg/m3. This value can be found in "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX." To date, however, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for VX.

VX is not listed by the International Agency for Research on Cancer (IARC), American Conference of Governmental Industrial Hygienists (ACGIH), Occupational Safety and Health Administration (OSHA), or National Toxicology Program (NTP) as a carcinogen.

EFFECTS OF OVEREXPOSURE: VX is a lethal cholinesterase inhibitor. Doses which are potentially life-threatening may be only slightly larger than those producing least effects. Death usually occurs within 15 minutes after absorption of a fatal dosage.

VX Route
ocular
inhalation
inhalation (15 1/min)
inhalation (15 1/min)
percutaneous Form
vapor
vapor
vapor
vapor
liquid Effect
miosis
runny nose
severe incapacitation
death
death Type
ECt50
ECt50
ICt50
LCt50
LD50 Dosage
<0.09 mg-min/m3
<0.09 mg-min/m3
25 mg-min/m3
30 mg-min/m3
10 mg/70 kg man Effective dosages for vapor are estimated for exposure durations of 2-10 minutes.

Symptoms of overexposure may occur within minutes or hours, depending

upon the dose. They include: miosis (constriction of pupils) and visual effects, headaches and pressure sensation, runny nose and nasal congestion, salivation, tightness in the chest, nausea, vomiting, giddiness, anxiety, difficulty in thinking, difficulty sleeping, nightmares, muscle twitches, tremors, weakness, abdominal cramps, diarrhea, involuntary urination and defecation. With severe exposure symptoms progress to convulsions and respiratory failure.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Hold breath until respiratory protective mask is donned. If severe signs of agent exposure appear (chest tightens, pupil constriction, incoordination, etc.), immediately administer, in rapid succession, all three Nerve Agent Antidote Kit(s), Mark I injectors (or atropine if directed by physician). Injections using the Mark I kit injectors may be repeated at 5 to 20 minute intervals if signs and symptoms are progressing until three series of injections have been administered. No more injections will be given unless directed by medical personnel. In addition, a record will be maintained of all injections given. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exists. If breathing is difficult, administer oxygen. Seek medical attention IMMEDIATELY.

EYE CONTACT: IMMEDIATELY flush eyes with water for 10-15 minutes, then don respiratory protective mask. Although miosis (pinpointing of the pupils) may be an early sign of agent exposure, an injection will not be administered when miosis is the only sign present. Instead, the individual will be taken IMMEDIATELY to a medical treatment facility for observation.

SKIN CONTACT: Don respiratory protective mask and remove contaminated clothing. Immediately wash contaminated skin with copious amounts of soap and water, 10% sodium carbonate solution, or 5% liquid household bleach. Rinse well with water to remove excess decontaminant. Administer nerve agent antidote kit, Mark I, only if local sweating and muscular twitching symptoms are observed. Seek medical attention IMMEDIATELY .

INGESTION: Do not induce vomiting. First symptoms are likely to be gastrointestinal. IMMEDIATELY administer Nerve Agent Antidote Kit, Mark I. Seek medical attention IMMEDIATELY .

SECTION VI - REACTIVITY DATA

STABILITY: Relatively stable at room temperature. Unstabilized VX of 95% purity decomposes at a rate of 5% a month at 71 C.

INCOMPATIBILITY: Negligible on brass, steel, aluminum.

HAZARDOUS DECOMPOSITION PRODUCTS: During a basic hydrolysis of VX up to

10% of the agent is converted to diisopropylaminoethyl methylphosphonothioic acid (EA2192). Based on the concentration of EA2192 expected to be formed during hydrolysis and its toxicity (1.4 mg/kg dermal in rabbit at 24 hours in a 10/90 wt.% ethanol/water solution), a Class B poison would result. The large scale decon procedure, which uses both HTH and NaOH, destroys VX by oxidation and hydrolysis. Typically the large scale product contains 0.2 - 0.4 wt.% EA2192 at 24 hours. At pH 12, the EA2192 in the large scale product has a half-life of about 14 days. Thus, the 90-day holding period at pH 12 results in about a 64-fold reduction of EA2192 (six half-lives). This holding period is sufficient to reduce the toxicity of the product below that of a Class B poison. Other less toxic products are ethyl methylphosphonic acid, methylphosphinic acid, diisopropyaminoethyl mercaptan, diethyl methylphosphonate, and ethanol. The small scale decontamination procedure uses sufficient HTH to oxidize all VX thus no EA2192 is formed.
HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If leaks or spills occur, only personnel in full protective clothing (See Section VIII) will remain in area. In case of personnel contamination see (Section V) for emergency and first aid instructions.
RECOMMENDED FIELD PROCEDURES (For Quantities greater than 50 grams): (NOTE: These procedures can only be used with the approval of the Risk Manager or qualified safety personnel). Spills must be contained by covering with vermiculite, diatomaceous earth, clay or fine sand. An alcoholic HTH mixture is prepared by adding 100 milliliters of denatured ethanol to a 900-milliliter slurry of 10% HTH in water. This mixture should be made just before use since the HTH can react with the ethanol. Fourteen grams of alcoholic HTH solution are used for each gram of VX. Agitate the decontamination mixture as the VX is added. Continue the agitation for a minimum of one hour. This reaction is reasonablely exothermic and evolves substantial off gassing. The evolved reaction gases should be routed through a decontaminate filled scrubber before release through filtration systems. After completion of the one hour minimum agitation, 10% sodium hydroxide is added in a quantity equal to that necessary to assure that a pH of 12.5 is maintained for a period not less than 24 hours. Hold the material at a pH between 10 and 12 for a period not less than 90 days to ensure that a hazardous intermediate material is not formed (See Section VI). Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the

container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, State, and local regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

If the alcoholic HTH mixture is not available then the following decontaminants may be used instead and are listed in the order of preference: Decontaminating Agent D2 (DS2), Supertropical Bleach Slurry (STB), and Sodium Hypochlorite.

RECOMMENDED LABORATORY PROCEDURES (For Quantities less than 50 grams):

If the active chlorine of the Calcium Hypochlorite (HTH) is at least 55%, then 80 grams of a 10% slurry are required for each gram of VX. Proportionally more HTH is required if the chlorine activity of the HTH is lower than 55%. The mixture is agitated as the VX is added and the agitation is maintained for a minimum of one hour. If phasing of the VX/decon solution continues after 5 minutes, an amount of denatured ethanol equal to a 10 wt.% of the total agent/decon will be added to help miscibility. Scoop up all material and clothing and place in a DOT approved container. Cover the contents with decontaminating solution as above. After sealing, the exterior of the container will be decontaminated and labeled according to EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exteriorcontainers. Decontaminate and label according to EPA and DOT regulations. Dispose of the material according to waste disposal methods provided below. Dispose of decontaminate according to Federal, State, and local regulations. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

NOTE: ETHANOL SHOULD BE REDUCED TO PREVENT THE FORMATION OF A HAZARDOUS

WASTE. Upon completion of the one hour agitation the decon mixture will be adjusted to a pH between 10 and 11. Conduct general area monitoring to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).

WASTE DISPOSAL METHOD: Open pit burning or burying of VX or items containing or contaminated with VX in any quantity is prohibited. The detoxified VX (using procedures above) can be thermally destroyed by in a EPA approved incinerator in accordance with appropriate provisions of Federal, State and local Resource Conservation and Recovery Act (RCRA) regulations.

NOTE: Some states define decontaminated surety material as a RCRA

Hazardous Waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION: CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT
<0.00001 mg/m3A full face piece, chemical canister, air-purifying protective mask will be on hand for escape.
(The M9-, M17-, or M40-series masks are acceptable for this purpose. Other masks certified as equivalent may be used). >0.00001 or = 0.02 mg/m3A NIOSH/MSHA approved pressure demand full face piece SCBA or supplied air respirators with escape air cylinder may be used. Alternatively, a full face piece, chemical canister air-purifying protective mask is acceptable for this purpose (See DA PAM 385-61for determination of appropriate level) >0.02 mg/m3 or unknownNIOSH/MSHA approved pressure demand full f ace piece SCBA suitable for use in high agent concentrations with protective ensemble (See DA PAM 385-61 for examples). VENTILATION:
Local exhaust: Mandatory. Must be filtered or scrubbed to limit exit concentration to Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross-drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke-producing devices will be performed in assessing the ability of the hood to contain agent VX.
Other: Recirculation or exhaust air from chemical areas is prohibited. No connection between chemical areas and other areas through ventilation system is permitted. Emergency backup power is necessary. Hoods should be tested at least semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hood face.
PROTECTIVE GLOVES: Butyl Rubber Glove M3 and M4 Norton, Chemical Protective Glove Set
EYE PROTECTION: At a minimum chemical goggles will be worn. For splash hazards use goggles and face shield.
OTHER PROTECTIVE EQUIPMENT: For laboratory operations, wear lab coats, gloves and have mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.

MONITORING: Available monitoring equipment for agent VX is the M8/M9 detector paper, detector ticket, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS), Real-Time Monitor (RTM), Demilitarization Chemical Agent Concentrator (DCAC), M8/M43, M8A1/M43A1, CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), the Miniature Chemical Agent Monitor (MINICAM), and the Real Time Analytical Platform (RTAP). Real-time, low-level monitors (with alarm) are required for VX operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents the buddy system will be incorporated. No smoking, eating, and drinking in areas containing chemicals is permitted. Containers should be periodically inspected for leaks (either visually or by a detector kit). Stringent control over all personnel practices must be exercised. Decontamination equipment will be conveniently located. Exits must be designed to permit rapid evacuation.Chemical showers, eyewash stations and personal cleanliness facilities must be provided. Wash hands before meals, each worker will shower thoroughly with special attention given to hair, face, neck, and hands, using plenty of soap and water before leaving at the end of the workday.
OTHER PRECAUTIONS: VX must be double contained in liquid and vapor tight containers when in storage or outside a ventilation hood.
For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-8, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX."

SECTION X - TRANSPORTATION DATA

PROPER SHIPPING NAME: Poisonous liquids, n.o.s.
DOT HAZARD CLASS: 6.1 Packing Group I, Zone A
DOT LABEL: Poison
DOT MARKING: Poisonous liquids, n.o.s. (O-ethyl S-(2-diisopropylaminoethyl)methyl phosphonothiolate) UN 2810, Inhalation Hazard
DOT PLACARD: Poison
EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII

and
VIII.
PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded, regardless of quantity. Drivers will be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipments of agent will be escorted in accordance with AR 740-32.

While the Edgewood Research Development and Engineering Center, Department of the Army believes that the data contained herein are factual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

DISTILLED MUSTARD (HD)

SECTION I - GENERAL INFORMATION

DATE: 22 September 1988
REVISED: 28 February 1996
MANUFACTURER'S ADDRESS:
U.S. ARMY CHEMICAL BIOLOGICAL DEFENSE COMMAND
EDGEWOOD RESEARCH DEVELOPMENT, AND ENGINEERING CENTER (ERDEC)
ATTN: SCBRD-ODR-S
ABERDEEN PROVING GROUND, MD 20101-5423
Emergency telephone #' s: 0700-1630 EST: 410-671-4411/4414
After: 1630 EST: 410- 278-5201, Ask for Staff Duty Officer
CAS REGISTRY NUMBERS: 505-60-2, 39472-40-7, 68157-62-0
CHEMICAL NAME:
Bis-(2-chloroethyl)sulfide
TRADE NAMES AND SYNONYMS:
Sulfide, bis (2-chloroethyl)
Bis(beta-chloroethyl)sulfide
1,1'-thiobis(2-chloroethane)
1-chloro-2(beta-chloroethylthio)ethane
Beta, beta'-dichlorodiethyl sulfide
2,2'dichlorodiethyl sulfide
Di-2-chloroethyl sulfide
Beta, beta'-dichloroethyl sulfide
2,2'-dichloroethyl sulfide
H; HD; HS
Iprit
Kampstoff "Lost"; Lost
Mustard Gas
S-Lost; S-yperite; Schewefel-lost
Senfgas
Sulfur mustard; Sulphur mustard gas
Yellow Cross Liquid
Yperite
Y
CHEMICAL FAMILY: Chlorinated sulfur compound
FORMULA/CHEMICAL STRUCTURE:
$C_4H_8Cl_2S$
NFPA 704 HAZARD SIGNAL:
Health - 4
Flammability - 1
Reactivity - 1
Special - 0

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENTS NAMEFORMULAPERCENTAGE BY WEIGHTAIRBORNE EXPOSURE LIMIT (AEL)
Sulfur MustardC4H8Cl2S1000.003 mg/m3

SECTION III - PHYSICAL DATA

BOILING POINT: 422 F 217 C
VAPOR PRESSURE (mm Hg):
0.072 mm Hg @ 20 C
0.11 mm Hg @ 25 C

VAPOR DENSITY (AIR=1): 5.5
SOLUBILITY IN WATER: Negligible. Soluble in acetone, CH3(Cl), tetrachloroethane, ethylbenzoate, and ether.
SPECIFIC GRAVITY (H2O=1): 1.27 @ 20 C
FREEZING POINT: 14.45 C
LIQUID DENSITY (g/cc):
1.268 @ 25 C
1.27 @ 20 C

PERCENTAGE VOLATILE BY VOLUME:
610 mg/m3 @ 20 C
920 mg/m3 @ 25 C

APPEARANCE AND ODOR: Normally amber to black colored liquid with garlic or a horseradish odor. Water clear if pure. The odor threshold for HD is 0.0006 mg/m3.

SECTION IV - FIRE AND EXPLOSION DATA

FLASHPOINT : 105 C (Can be ignited by large explosive charges)
FLAMMABILITY LIMITS (% by volume): Unknown
EXTINGUISHING MEDIA: Water, fog, foam, CO2. Avoid use of extinguishing methods that will cause splashing or spreading of HD.
SPECIAL FIRE FIGHTING PROCEDURES: All persons not engaged in extinguishing the fire should be immediately evacuated from the area. Fires involving HD should be contained to prevent contamination to uncontrolled areas. When responding to a fire alarm in buildings or areas containing agents, firefighting personnel should wear full firefighter protective clothing (without TAP clothing) during chemical

agent firefighting and fire rescue operations. Respiratory protection is required. Positive pressure, full face piece, NIOSH-approved self-contained breathing apparatus (SCBA) will be worn where there is danger of oxygen deficiency and when directed by the fire chief or chemical accident/incident (CAI) operations officer. In cases where firefighters are responding to a chemical accident/incident for . rescue/reconnaissance purposes they will wear appropriate levels of protective clothing (See Section VIII).
Do not breathe fumes. Skin contact with agents must be avoided at all times. Although the fire may destroy most of the agent, care must still be taken to assure the agent or contaminated liquids do not further contaminate other areas or sewers. Contact with the agent liquid or vapor can be fatal.

SECTION V - HEALTH HAZARD DATA

AIRBORNE EXPOSURE LIMIT (AEL): The AEL for HD is 0.003 mg/m3 as found in "AR 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Mustard Agents H, HD, HT." To date, the Occupational Safety and Health Administration (OSHA) has not promulgated a permissible exposure concentration for HD.
EFFECTS OF OVEREXPOSURE: HD is a vesicant (causing blisters) and alkylating agent producing cytotoxic action on the hematopoietic (blood-forming) tissues which are especially sensitive. The rate of detoxification of HD in the body is very slow and repeated exposures produce a cumulative effect. HD has been found to be a human carcinogen by the International Agency for Research on Cancer (IARC).
Median doses of HD in man are:
LD50 (skin) = 100 mg/kg ICt50 (skin) = 2000 mg-min/m3 at 70 - 80 F (humid environment)
= 1000 mg-min/m3 at 90 F (dry environment)
ICt50 (eyes) = 200 mg-min/m3
ICt50 (inhalation) = 1500 mg-min/m3 (Ct unchanged with time)
LD50 (oral) = 0.7 mg/kg
Maximum safe Ct for skin and eyes are 5 and 2 mg-min/m3, respectively.
ACUTE PHYSIOLOGICAL ACTION OF HD IS CLASSIFIED AS LOCAL AND SYSTEMIC.
LOCAL ACTIONS: HD effects both the eyes and the skin. SKIN damage occurs after percutaneous absorption. Being lipid soluble, HD can be absorbed into all organs. Skin penetration is rapid without skin irritation.
Swelling (blisters) and reddening (erythema) of the skin occurs after a latency period of 4-24 hours following the exposure, depending on degree of exposure and individual sensitivity. The skin healing process is very slow. Tender skin, mucous membrane and perspiration-covered skin are

more sensitive to the effects of HD. HD's effect on the skin, however, is less than on the eyes. Local action on the eyes produces severe necrotic damage and loss of eyesight Exposure of eyes to HD vapor or aerosol produces lacrimation, photophobia, and inflammation of the conjunctiva and cornea.
SYSTEMIC ACTIONS: Occurs primarily through inhalation and ingestion. The HD vapor or aerosol is less toxic to the skin or eyes than the liquid form. When inhaled, the upper respiratory tract (nose, throat, tracheae) is inflamed after a few hours latency period, accompanied by sneezing, coughing, and bronchitis, loss of appetite, diarrhea, fever, and apathy. Exposure to nearly lethal doses of HD can produce injury to bone marrow, lymph nodes, and spleen as showed by a drop in white blood cell count, thus resulting in increased susceptibility to local and systemic infections. Ingestion of HD will produce severe stomach pains, vomiting, and bloody stools after a 15-20 minute latency period.
CHRONIC EXPOSURE : HD can cause sensitization, chronic lung impairment, (cough, shortness of breath, chest pain), cancer of the mouth, throat, respiratory tract and skin, and leukemia. It may also cause birth defects.
EMERGENCY AND FIRST AID PROCEDURES:
INHALATION: Hold breath until respiratory protective mask is donned. Remove from the source IMMEDIATELY. If breathing is difficult, administer oxygen. If breathing has stopped, give artificial respiration. Mouth-to-mouth resuscitation should be used when approved mask-bag or oxygen delivery systems are not available. Do not use mouth-to-mouth resuscitation when facial contamination exits. Seek medical attention IMMEDIATELY.
EYE CONTACT: Speed in decontaminating the eyes is absolutely essential. Remove the person from the liquid source, flush the eyes immediately with water for at least 15 minutes by tilting the head to the side, pulling the eyelids apart with the fingers and pouring water slowly into the eyes. Do not cover eyes with bandages but, if necessary, protect eyes by means of dark or opaque goggles. Transfer the patient to a medical facility IMMEDIATELY.
SKIN CONTACT: Don respiratory protective mask. Remove the victim from agent sources immediately. Immediately wash skin and clothes with 5% solution of sodium hypochlorite or liquid household bleach within one minute. Cut and remove contaminated clothing, flush contaminated skin area again with 5% sodium hypochlorite solution, then wash contaminated skin area with soap and water. Seek medical attention IMMEDIATELY.
INGESTION: Do not induce vomiting. Give victim milk to drink. Seek medical attention IMMEDIATELY.

SECTION VI - REACTIVITY DATA

STABILITY: Stable at ambient temperatures. Decomposition temperature is 149 C to 177 C. Mustard is a persistent agent depending on pH and moisture, and has been known to remain active for up to three years in soil.
INCOMPATIBILITY: Rapidly corrosive to brass @ 65 C. Will corrode steel at a rate of .0001 in. of steel per month @ 65 C.
HAZARDOUS DECOMPOSITION: Mustard will hydrolyze to form HCl and thiodiglycol.
HAZARDOUS POLYMERIZATION: Does not occur.

SECTION VII - SPILL, LEAK, AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: If spills or leaks occur, only personnel in full protective clothing will remain in the area (See Section VIII). In case of personnel contamination See Section V for emergency and first aid instructions.
RECOMMENDED FIELD PROCEDURES: The HD should be contained using vermiculite, diatomaceous earth, clay or fine sand and neutralized as soon as possible using copious amounts of 5.25% sodium hypochlorite solution. Scoop up all material and clothing and place in a approved DOT container. Cover the contents of the container with decontaminating solution as above. The exterior of the container will be decontaminated and labeled according with EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with EPA and DOT regulations. Dispose of the material in accordance with waste disposal methods provided below. Dispose of the decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Sections II and VIII).
If 5.25 % sodium hypochlorite solution is not available then the following decontaminants may be used instead and are listed in the order of preference: Calcium Hypochlorite, contamination Solution No. 2 (DS2), and Super Tropical Bleach Slurry (STB).
WARNING: Pure, undiluted calcium hypochlorite will burn on contact with liquid HD.
RECOMMENDED LABORATORY PROCEDURES: A minimum of 65 grams of decon solution per gram of HD is allowed to agitate for a minimum of one hour. Agitation is not necessary following the first hour if a single phase is obtained. At the end of 24 hours, the resulting solution will be adjusted to a pH between 10 and 11. Test for presence of active chlorine by use of acidic potassium iodide solution to give free iodine color.

Place 3 ml of the decontaminate in a test tube. Add several crystals of potassium iodine and swirl to dissolve. Add 3 ml of 50 wt.% sulfuric acid:water and swirl. IMMEDIATE iodine color shows the presence of active chlorine. If negative, add additional 5.25% sodium hypochlorite solution to the decontamination solution, wait two hours, then test again for active chlorine. Continue procedure until positive chlorine is given by solution. A 10 wt.% calcium hypochlorite (HTH) mixture may be substituted for sodium hypochlorite. Use 65 grams of decon per gram of HD and continue the test as described for sodium hypochlorite. Scoop up all material and clothing and place in a approved DOT container. Cover the contents of the container with decontaminating solution as above. The exterior of the container will be decontaminated and labeled according with EPA and DOT regulations. All leaking containers will be over packed with vermiculite placed between the interior and exterior containers. Decontaminate and label in accordance with EPA and DOT regulations. Dispose of the material in accordance with waste disposal methods provided below. Dispose of the decontaminate according to Federal, state and local regulations. Conduct general area monitoring with an approved monitor to confirm that the atmospheric concentrations do not exceed the airborne exposure limits (See Section VIII).
NOTE: Surfaces contaminated with HD, then rinse and decontaminated may evolve sufficient HD vapor to produce a physiological response. HD on laboratory glassware may be oxidized by its vigorous reaction with concentrated nitric acid.
WASTE DISPOSAL METHOD: Open pit burning or burying of HD or items containing or contaminated with HD in any quantity is prohibited. Decontamination of waste or excess material will be accomplished according to the procedures outlined above can be destroyed by incineration in EPA approved incinerators according to appropriate provisions of Federal, State and local Resource Conservation Recovery Act (RCRA) regulations.
NOTE: Some states define decontaminated surety material as a RCRA hazardous waste.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION:
CONCENTRATIONRESPIRATORY PROTECTIVE EQUIPMENT. < 0.003 mg/m3A full face
piece, chemical canister, air purifying
protective mask will be on hand for escape.
(The M9-, M17-, or M40-series masks are
acceptable for this purpose. Other masks
certified as equivalent may be used) > 0.003 mg/m3A NIOSH/MSHA approved

pressure demand full
face piece SCBA suitable for use in high agent
concentrations with protective ensemble.
(See DA PAM 385-61 for examples).
VENTILATION:
Local Exhaust: Mandatory. Must be filtered or scrubbed. Air emissions will meet local, state and federal regulations.
Special: Chemical laboratory hoods will have an average inward face velocity of 100 linear feet per minute (lfpm) +/- 10% with the velocity at any point not deviating from the average face velocity by more than 20%. Existing laboratory hoods will have an inward face velocity of 150 lfpm +/- 20%. Laboratory hoods will be located such that cross drafts do not exceed 20% of the inward face velocity. A visual performance test using smoke producing devices will be performed in assessing the ability of the hood to contain agent HD.
Other: Recirculation of exhaust air from agent areas is prohibited. No connection between agent area and other areas through the ventilation system are permitted. Emergency backup power is necessary. Hoods should be tested semiannually or after modification or maintenance operations. Operations should be performed 20 centimeters inside hoods.
PROTECTIVE GLOVES: Butyl Rubber Gloves M3 and M4 Norton, Chemical Protective Glove Set
EYE PROTECTION: As a minimum, chemical goggles will be worn. For splash hazards use goggles and face shield.
OTHER PROTECTIVE EQUIPMENT: For laboratory operations, wear lab coats, gloves and have mask readily accessible. In addition, daily clean smocks, foot covers, and head covers will be required when handling contaminated lab animals.
MONITORING: Available monitoring equipment for agent HD is the M8/M9 detector paper, blue band tube, M256/M256A1 kits, bubbler, Depot Area Air Monitoring System (DAMMS), Automated Continuous Air Monitoring System (ACAMS),CAM-M1, Hydrogen Flame Photometric Emission Detector (HYFED), the Miniature Chemical Agent Monitor (MINICAM), and Real Time Analytical Platform (RTAP).
Real-time, low-level monitors (with alarm) are required for HD operations. In their absence, an Immediately Dangerous to Life and Health (IDLH) atmosphere must be presumed. Laboratory operations conducted in appropriately maintained and alarmed engineering controls require only periodic low-level monitoring.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: When handling agents, the buddy system will be incorporated. No smoking, eating, or drinking

in areas containing agents is permitted. Containers should be periodically inspected for leaks, (either visually or using a detector kit). Stringent control over all personnel practices must be exercised. Decontaminating equipment will be conveniently placed. Exits must be designed to permit rapid evacuation. Chemical showers, eyewash stations, and personal cleanliness facilities must be provided. Wash hands before meals and shower thoroughly with special attention given to hair, face, neck, and hands using plenty of soap and water before leaving at the end of the work day .
OTHER PRECAUTIONS: HD should be stored in containers made of glass for Research, Development, Test and Evaluation (RDTE) quantities or one-ton steel containers for large quantities. Agent will be double-contained in liquid and vapor tight containers when in storage.
For additional information see "AR 385-61, The Army Toxic Chemical Agent Safety Program," "DA PAM 385-61, Toxic Chemical Agent Safety Standards," and "AR 40-173, Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to HD Agents H, HD, and HT."

SECTION X - TRANSPORTATION DATA

FORBIDDEN FOR TRANSPORT OTHER THAN VIA MILITARY (TECHNICAL ESCORT UNIT)
TRANSPORT ACCORDING TO 49 CFR 172
PROPER SHIPPING NAME: Poisonous liquids, n.o.s.
DOT HAZARD CLASS: 6.1, Packing Group I, Hazard Zone B
DOT LABEL: Poison
DOT MARKING: Poisonous liquids, n.o.s. Bis-(2-chloroethyl) sulfide UN 2810, Inhalation Hazard
DOT PLACARD: POISON
EMERGENCY ACCIDENT PRECAUTIONS AND PROCEDURES: See Sections IV, VII and
VIII.
PRECAUTIONS TO BE TAKEN IN TRANSPORTATION: Motor vehicles will be placarded regardless of quantity. Drivers shall be given full information regarding shipment and conditions in case of an emergency. AR 50-6 deals specifically with the shipment of chemical agents. Shipment of agents will be escorted in accordance with AR 740-32.

While the Edgewood Research Development, and Engineering Center, Department of the Army believes that the data contained herein are actual and the opinions expressed are those of the experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which the Department of the Army or

Edgewood Research Development, and Engineering Center assume legal responsibility. They are offered solely for your consideration, investigation, and verification. Any use of these data and information must be determined by the user to be in accordance with applicable Federal, State, and local laws and regulations.

ADDENDUM A
ADDITIONAL INFORMATION FOR THICKENED HD
TRADE NAME AND SYNONYMS: Thickened HD, THD
HAZARDOUS INGREDIENTS: K125 (acryloid copolymer, 5%) is used to thicken HD. K125 is not known to be hazardous except in a finely-divided, powder form.
PHYSICAL DATA: Essentially the same as HD except for viscosity. The viscosity of HD is between 1000 and 1200 centistoke @ 25 C.
FIRE AND EXPLOSION DATA: Same as HD.
HEALTH HAZARD DATA: Same as HD except for skin contact. For skin contact, don respiratory protective mask and remove contaminated clothing IMMEDIATELY. IMMEDIATELY scrape the HD from the skin surface, then wash the contaminated surface with acetone. Seek medical attention IMMEDIATELY.
SPILL, LEAK, AND DISPOSAL PROCEDURES: If spills or leaks of HD occur, follow the same procedures as those for HD, but dissolve THD in acetone before introducing any decontaminating solution. Containment of THD is generally not necessary. Spilled THD can be carefully scraped off the contaminated surface and placed in a fully removable head drum with a high density, polyethylene lining. THD can then be decontaminated, after it has been dissolved in acetone, using the same procedures used for HD. Contaminated surfaces should be treated with acetone, then decontaminated using the same procedures as those used for HD.
NOTE: Surfaces contaminated with THD or HD and then rinse-decontaminated may evolve sufficient HD vapor to produce a physiological response.
SPECIAL PROTECTION INFORMATION: Same as HD.
SPECIAL PRECAUTIONS: Same as HD with the following addition. Handling THD requires careful observation of the "stringers" (elastic, threadlike attachments) formed when the agents are transferred or dispensed. These stringers must be broken cleanly before moving the contaminating device or dispensing device to another location, or unwanted contamination of a working surface will result.
TRANSPORTATION DATA: Same as HD.

The Biological Weapon: A Poor Nation's Weapon of Mass Destruction

Lt Col Terry N. Mayer, USAF

Prologue-4 January

This is a CNN special report. This just in. The Center for Disease Control has just declared that an epidemic is widespread in Miami, Florida. Doctors have not yet diagnosed the specific cause of the rampant disease, but the illness initially resembles a chest cold that progresses into pneumonia-like symptoms. It then progresses rapidly into fever and shortness of breath. What is especially peculiar about this epidemic is that all the patients who have sought medical attention attended the Orange Bowl football game on New Year's Day. Authorities have asked that anyone who went to that game seek medical care if cold-like symptoms appear. Stay tuned to CNN for further developments on this story. Elsewhere in the news ...

The Biological Warfare Context

This is a notional, yet frightening illustration of what the first signs of a biological warfare (BW) attack might sound like. This scenario is a plausible example of an attack a terrorist or deranged person might conduct using off-the-shelf technology and readily available biological warfare agents. The "concept of operations" in this attack consisted of using several insect bombs (the kind where you push the button, it starts spraying, and you leave the house for two hours) and modifying them by filling the canister with anthrax bacteria bought through a mail order specimen company in the United States. If that doesn't sound credible, please note that Saddam Hussein bought his original anthrax culture from a mail order house in the United States and had it shipped overnight mail!1 This is just a sample of many plausible scenarios that could employ biological warfare agents in a terrorist or combat operation.

The spring 1995 chemical warfare attack in the subways of Tokyo is a glaring example of just how susceptible modern society is to this kind of insidious attack. It does not take a great deal of imagination to conceive of other situations and vulnerabilities that would make very lucrative targets for a biological weapons strike. If an attacker has access to the target area, a simple mechanism to aerosolize a substance, and a basic biology laboratory, the prerequisites are complete. This is not a high-tech arena that requires specialized equipment or core material as do nuclear weapons; this is basic college biology coupled with motivation. While the use of this weapon has not been prevalent in recent years, the threat is real, the United States' vulnerability is clear, and the ability to counter the biological weapon is almost nil. A study of biological warfare raises some fundamental questions:

•Just what is biological warfare?
•What is the history of biological warfare and how important is it today?
•What biological warfare agents are available for use today?
•What is the biological warfare threat?
•How capable are we of coping with the threat?
•What policy should the United States follow to close the gap between the threat and the capability?

The purpose of this article is to raise the awareness level about a very real and probable threat that has not been dealt with effectively. The author hopes to bring the issue to the front burner for study and to apply resources to resolving the tough problems. While the paper identifies where precious resources should be focused, it does not profess to have all the answers to the very difficult biological warfare dilemma.

First, what is biological warfare in layman's terms? From a military perspective, it is the intentional use of diseases to affect an adversary's military force, population, crops, or livestock. Certainly, a terrorist biological campaign could target those same kinds of objectives, depending on the perceived purpose of the terrorist. There are two basic categories of biological warfare agents. Microorganisms are living organic germs, such as anthrax (bacillus anthrax). Second, toxins are the byproducts of living organisms, or effectively natural poisons, such as botulism (botulinum toxin) which is a byproduct of growing the microorganism clostridium botulinum.2 These are only two examples of biological warfare agents, although these are especially prevalent and virulent examples. There are many other natural and man-made agents that have been used throughout history.

Historical Perspective

Biological warfare is not a twentieth century development; it has been an effective combat weapon for centuries. As early as 1346 A.D., Tartars held the walled city of Kaffa under siege and catapulted plague-infested bodies into the city.3 Were the Tartars successful in using disease as a means to break the siege? Yes. Not only did illness cause Kaffa to capitulate, but some medical historians speculate this event resulted in the bubonic plague epidemic that spread across medieval Europe between 1347 and 1351, killing 25 million people.4 Three hundred years later, during the French and Indian War, the English offered blankets to Indians holding Fort Carillon. The English suspected the Indians were loyal to the French and exposed the blankets to the smallpox virus before their apparent altruistic overture. The Indians began to fall ill, and after an epidemic spread through the fort, the English attacked, defeating the incapacitated force. The British gained control of Fort Carillon and renamed it Fort Ticonderoga.5 Throughout history, many examples may be found illustrating the use of natural diseases in war to place an adversary in a position of disadvantage. For example, dumping bodies into water supplies has been fairly common for centuries.

Two thousand years ago, Romans fouled many of their enemies' water sources by throwing the corpses of dead animals into the wells.6 During the American Civil War, Confederate soldiers shot horses and other farm animals in ponds in an effort to contaminate the water supply of the Union forces.7 While there was some evidence of biological warfare in World War I8 , the interwar years saw a new interest in the use of disease as a weapon. Paradoxically, probably the two most active programs started as a result of an international initiative to ban biological warfare agents. Both Japan and the United Kingdom recognized that since biological warfare was horrifying enough to outlaw, it probably would make an effective weapon. Both countries had very robust programs as early as 1932 and 1934, respectively.9 There is evidence that Japan tested biological warfare agents on prisoners of war and that they actually used them on the population of China.10 To spread the plague, they dropped flea-infested debris over 11 cities in mainland China. The result was a bubonic plague epidemic in China and Manchuria.11 While these attacks caused casualties, the weapons did not function reliably and ultimately resulted in very little strategic impact that affected the war.12 When the Britain learned of the Japanese biological warfare program, they put significantly more emphasis toward developing their own BW capability. Most of their testing was conducted on an island called Gruinard off the northwest coast of Scotland. They concentrated their development and testing efforts on the lethal effects of anthrax. Scientists used sheep as victims to evaluate the effectiveness of the disease, and they infected literally thousands of animals. As a result of the huge amount of anthrax agent dispersed on the island and the large number of sheep infected, the British could not effectively decontaminate the island after they stopped the testing program. Consequently, Gruinard is still considered contaminated and is off limits, demonstrating the persistence of anthrax as a biological weapon.13 The British soon combined their biological weapons development efforts with Canada and the United States. Even though there were Allied operational plans to employ biological weapons during World War II, there is no evidence to indicate they were actually used on a large scale. There is, however, strong evidence that Reinhard Heydrich, chief of the Nazi security service, was assassinated with a grenade that had been contaminated with biological warfare agents (typhoid fever).14

Biological Warfare in the Cold War

After World War II and during the Korean War, the focus, at least from the United States perspective, was on building a BW retaliatory capability. The US developed an anticrop bomb and delivered it to the Air Force in 1951. It could have been used to attack North Korean rice fields, reducing a significant source of nutrition for the population.15 North Korea accused the United States of using biological agents during the Korean War; the United States denied the accusation, and there was no substantive proof offered in the open literature.16 Following the Korean War, the United States invigorated the biological warfare program in 1956 after Marshal Zhukov announced to the Soviet Congress that chemical and biological warfare weapons would be used as weapons of mass destruction in future wars. This was a dramatic

shift inSoviet policy and the cold war philosophy.17 The fundamental concept of United States biological warfare operations changed as a result. During the Korean War, the biological capability was maintained primarily for retaliation in the event an adversary employed a biological agent against United States or allied forces. The prevailing philosophy was that the threat of retaliation in kind would deter the use of these kinds of weapons. After the new Soviet pronouncement, the United States concept changed to employment upon executive order by the president of the United States.18 Effectively, this mimicked the Soviet position, implying that the United States might use biological weapons in situations other than straightforward retaliation. This change in policy boosted the biological warfare research effort in the United States. The bulk of the research was conducted at Fort Detrick in Maryland. It was during this "boost phase" that United States vulnerability was clearly demonstrated with simulated covert biological warfare attacks on at least three cities subway systems. Surrogate biological agents were introduced into the air vents of the underground systems. Samples were then taken to determine how widespread the dissemination would be. The results demonstrated that large numbers of the populace would be exposed to infectious doses under such an attack.19 This experiment supported a similar test that took place in 1950 when an aerosol cloud of a simulated biological agent was sprayed off the coast of San Francisco. The test results showed that nearly 100 percent of the population had inhaled potentially lethal doses.20 In 1969, President Nixon changed the United States policy on biological warfare. During a visit to Fort Detrick, he announced that the United States was terminating research on biological warfare and was unilaterally disarming any capability to conduct offensive biological warfare. By 1972, the United States biological weapons stockpile was completely destroyed.21 This gesture by the United States was the catalyst for the world community to embrace the Biological and Toxin Weapons Convention (BWC). A total of 118 countries (including the USSR and Iraq) signed up to abide by the BWC, which directs that the signatories will "never in any circumstances develop, produce, stockpile, or otherwise acquire or retain any biological weapons."22 During this time, the Second Indochina War was raging. However, there is no clear evidence that biological warfare agents were used in this conflict. Agent Orange, a herbicide, was a chemical-based agent that saw wide use, but biological weapons per se were not used.23 While the United States biological warfare program was flourishing and even after our unilateral biological warfare disarmament, there is evidence that the Soviet program was thriving, although they had signed the BWC in 1972. In the late 1970s and early 1980s, there were reports that the Soviets used biological weapons in Laos, Kampuchea, and Afghanistan. While widely reported as a program called "Yellow Rain," these allegations were never proven.24 In 1978, Georgi Markov, a popular writer and Bulgarian exile, was walking to the BBC in London where he broadcast to his homeland from Radio Free Europe. As he was walking, he suddenly felt a sharp pain in his leg. Turning around, he confronted a man picking up an umbrella. The man apologized and went on his way. Markov took ill that night and died several days later. The autopsy found a small metal pellet coated with ricin, a biological toxic substance derived from the castor oil plant.25

Another incident occurred in April 1979 when a loud explosion was reported from a research compound in Sverdlovsk, USSR. Over the next few days, reports of an outbreak of anthrax surfaced. The United States claimed that the outbreak was the result of an accident in a biological warfare production plant. The USSR vehemently denied the accusations, claiming it was caused by tainted black market meat and poor hygiene among the population. In the media and technical literature before 1992, many Western journalists and scientists argued that the facts supported the Soviet claims.26 However, in 1992, Russian President Boris Yeltsin admitted that the Sverdlovsk incident was actually a biological warfare accident involving anthrax.27 Thereafter, President Yeltsin signed a decree that recommitted Russia to the Biological and Toxin Weapons Convention. But in 1994, three defectors revealed an ongoing Russian biological warfare program that concentrates on a "superplague" for which, reportedly, the West has no antidote. President Yeltsin claimed he didn't know about any biological warfare programs. The defectors verified his claim and inferred that the military is running the program without Yeltsin's knowledge or consent.28

Biological Terrorism

In 1984, the French authorities made a startling discovery that demonstrates how vulnerable the world is to biological terrorism. The Paris Police raided a residence suspected of being a safe house for the German Red Army Faction. As they conducted their search, they found documents that revealed a strong working knowledge of lethal biological agents. As the police continued the search to the bathroom, they came across a bathtub containing many flasks filled with what turned out to be Clostridium Botulinum, the microorganism that produces botulism, one of the most lethal biological substances known to man.29 On 20 March 1995, the Tokyo subway system was attacked with chemical warfare agents by, allegedly, a cult called the Aum Shinri Kyo, or the Supreme Truth. This incident killed at least 11 people and injured as least 5,500 others.30 Five different subway cars were struck simultaneously by individuals leaving canisters dispersing a Nazi-developed nerve agent called Sarin.31 This is an exceptionally significant event because it strikes at the core of society with furtive lethal gases, exposing glaring vulnerabilities and fomenting terror among the population. As one victim of the subway attack said, "We're just innocent, ordinary people. It frightens me to think how vulnerable we are."32 On the 28th of March, Tokyo police also found large quantities of the biological warfare agent Clostridium Botulinum during one of several raids on Aum Shinri Kyo facilities.33 This discovery clearly demonstrates that a terrorist organization had the resolve, the biological agent, and the wherewithal to conduct a horrendous biological attack against an unprotected population. As Time magazine said, ". . . garden-variety madness had got access to weapons of terror."34

BW and the 1991 Gulf War

These recent world biological warfare events have been alarming, but what really

brought the biological warfare issue into the spotlight of the public's eye was the experience in Desert Storm, the Persian Gulf War. By the time of the Iraqi invasion into Kuwait, it was widely acknowledged that Iraq had a biological warfare program, concentrated on very toxic botulinum toxin and very resilient anthrax.35 This assessment was derived from a compilation of several sources and indicators, the most dramatic being an Iraqi defector who was a microbiologist. He told a British newspaper correspondent that as early as 1983 Iraqi scientists were developing and testing biological warfare agents: There were many strains, botulism, salmonella, and anthrax. Friends told me they had found a way to make anthrax even more toxic. I know they experimented on sheep with Clostridium Botulinum type C (the source of botulinum toxin).36

The defector said he personally had done research and solved difficult technical problems relating to the weaponization and deployment of biological warfare agents.37 This has since been confirmed officially by a representative of Saddam Hussein's present government. On 2 August 1990, when Iraqi army invaded Kuwait, the Iraqis had spent close to $100 million on their offensive biological warfare program and had a significant stockpile of biological warfare agents.38 Saddam Hussein announced "loud and clear" that this war would be the "mother of all wars," implying a no-holds-barred engagement.39 This was the first time since World War II that the United States had faced a military adversary with a highly probable biological warfare capability and the resolve to use it.40 The United States was challenged not only with how to protect the military forces but how to preempt the use of Saddam's biological warfare arsenal. Plans for force protection included protective equipment and vaccinations against probable biological warfare threats.41 In addition, planners were challenged to determine a mechanism to destroy the biological warfare stockpiles before Saddam could deploy them. Dropping a precision-guided bomb on the suspected storage bunkers would have been easy enough. The real challenge was destroying the viability or utility of the biological weapons without spreading the agents and causing massive collateral damage in terms of human lives. The military was simply not prepared for this eventuality. Several tests were conducted over a very short time to try to find the right kind of enhanced munitions or bomb that would render the biological warfare agent unusable to the Iraqis and not release lethal agents into the atmosphere. The crash program was not fruitful. However, in the effort, computer modeling showed that the design of the suspected biological weapons storage bunkers offered a bombing approach that might inhibit the release of the agents. In the eleventh hour, this concept detailing specific fusing, type of bomb, and angle of attack was telephoned to the Central Command CENTCOM planners in Riyadh.42 All suspected bunkers were attacked, and there was no confirmed collateral damage as a result of released biological agent. There was, however, one unconfirmed news report of several incidents of illness and death in Iraqi guards after the coalition bombed abiological warfare facility in Baghdad.43 In the end, it appears that Saddam Hussein did not use biological weapons during Desert Storm. While the Iraqi rationale may never be known for certain, it is likely that they were deterred by public signals like the one Secretary of Defense Dick Cheney announced during a news conference on 23

December 1990.44 . . . Cheney said that "were Saddam Hussein foolish enough to use weapons of mass destruction, the US response would be absolutely overwhelming and it would be devastating."45
In an even more direct and unambiguous message, a 5 January 1991 letter President George Bush said to Saddam Hussein: "The United States will not tolerate the use of chemical or biological weapons... The American people would demand the strongest possible response. You and your country will pay a terrible price if you order unconscionable acts of this sort."46 After the cease fire, Iraq officialsadmitted having a biological warfare program that they said had only progressed to the research stage. Inspectors found evidence of a robust biological warfare production capability, but could not specifically link it to the biological warfare program. However, there was overwhelming circumstantial evidence that an offensive biological warfare production and weaponization program did exist.47 Like the Soviet Union, Iraq had previously signed the BWC. The bad news is that United Nations inspectors were not able to locate Saddam's biological stockpile.48 Saddam's representatives have since admitted to the United Nations inspectors that they had a sizable cache of anthrax and botulism agents, but they claim to have destroyed it to avoid having germs spread over the Iraqi countryside by allied bombing attacks. Having witnessed the bold Iraqi deceptive effort regarding their nuclear research program, the world has every reason to believe that Saddam Hussein still has a large amount of biological warfare agents at his disposal today.49 On 24 February 1993, former CIA Director James Woolsey told the Senate Govern- mental Affairs Committee: "Iraq's biological weapons capability is perhaps of greatest immediate concern. Baghdad had an advanced program before Desert Storm, and neither war nor inspections have seriously degraded this capability. The dual-use nature of biological weapon equipment and techniques makes this the easiest program to hide."50

The Biological Warfare Threat

With the public exposé of active Russian and Iraqi biological warfare programs, the threat of these weapons looms large on the horizon. There are official, open-source estimates that between 10 and 20 countries either have, want, or are thinking about starting a biological weapons capability.51 However, there is more to the threat than just countries that have the capability. What types of agents are a threat and how will they mature given new technology? And, does the insidious nature of biological agents pose a threat?

BW Nation States
Some of the countries suspected in open sources of having or wanting a biological warfare program include Russia, Syria, Iraq, Iran, Libya, North Korea, Israel, Egypt, Cuba, Taiwan, China, Romania, Bulgaria, Pakistan, India, and South Africa.52 There are real concerns with this list. First, some of these nations have been associated in the past with state-supported terrorism. This fact raises the probability of a biological warfare terrorist attack. Second, many of these countries reside in regions of historical

instability or emerging instability. And third, with the economic distress in the former Soviet Union, there is a possibility that its biological warfare weapons experts will look for more prosperous employment by building biological warfare programs elsewhere for the highest bidder. Fortunately, as of early 1994, the CIA had no indication that this biological warfare brain drain is occurring.53

Biological Warfare Technology

The degree of sophistication of each country's research program will determine how advanced biological agents will be. Even the most rudimentary program will likely have lethal agents that have been a threat for some time. Botulism and anthrax (mentioned earlier) are high-probability candidates that are difficult to reckon with. In addition, the revolution in biotechnology may produce other agents that are even more toxic and resilient. Without getting into the technical aspects, relatively minor molecular adjustments may produce a more toxic, fast acting, and stable biological agent.54 There is also a possibility that genetic engineering may produce a weapon that is unique and can only be protected against with a unique vaccine.55 These two examples of potential developments in biological warfare will give this weapon a great deal more utility, especially on the battlefield. A more stable agent that produces an accelerated reaction would provide the tactical commander with a viable tactical weapon.

Additionally, if the commander could deploy biological agents against an enemy while friendly troops remained invulnerable, the biological option would become much more attractive as a battlefield weapon. There is also some speculation that a toxic agent could be produced that would target only a specific genetic makeup, giving an attacker the capability to discriminate among age, gender, racial or behavior groups as target sets.56 Following the Tokyo subway attack, it has come to light that the Aum Shinri Kyo had recently ordered sophisticated molecular design software. The purpose of this type of software is to reengineer the molecular structure of chemicals or microorganisms to make them stronger or more dangerous.57 Could it be that this fanatic cult was planning to use this software to genetically reengineer their biological or chemical agents?

Stealthy BW

Now the really sobering part—biological warfare agents are very difficult, if not impossible, to detect while they are in the research, production, transit, or employment phases. Normal biological warfare research facilities resemble completely legitimate biotechnical and medical research facilities. The same production facilities that can produce biological warfare agents may also produce wine and beer, dried milk, food, and agricultural products.58 The challenge this presents is in distinguishing legitimate production plants from illicit ones. It becomes nearly impossible to identify the locations and facilities that are actually producing biological warfare weapons. This needs to be done, obviously, in order to confidently highlight a violation of the BWC, or,

if necessary, should all peaceful remedies fail, preemptively strike a biological weapons production or storage facility. In addition, biological warfare agents are virtually undetectable while they are in transit. In other words, if a terrorist wanted to carry the biological agent into the United States in a carry-on bag or checked luggage, there is no mechanism using routine customs, immigration, drug scan, or bomb search procedures to identify the agent. The only way to find it would be a physical search by a very well trained and very lucky searcher.59 Similarly, the threat on the battlefield is almost as insidious, with very little present detection capability. Desert Storm represents a recent experience in which the United States needed the ability to detect biological warfare agents to give early warning for protective measures. With few exceptions, the capability was not there. The limited capability that was deployed was the result of a crash program to produce a biological detector—it was an experiment.60 It seems logical that the inability to detect and thereby protect the civilian population or military force would significantly add to the viability of biological weapons as a terrorist or tactical battlefield threat.

Shortfalls

In addition to the detection shortfall, the United States is unable to effectively protect the military forces (medically and nonmedically), conduct an effective preemptive counteroffensive strike, or protect the population against a terrorist attack. Given the wide spectrum of kinds of agents that make up the biological warfare threat, medical prophylactic measures (primarily vaccinations) are inadequate, and it appears they will be so at least for the near-term.61 Personal protection in a biological warfare environment currently depends on protective clothing— the chemical warfare suit. In Desert Storm, the chemical warfare suit was adequate if fitted properly (a frequent problem) but unsuitable if worn for long durations or while in hot weather.62 Desert Storm also highlighted the shortfall in the ability to strike a biological warfare storage facility with confidence that massive numbers of innocent civilians would not be killed (collateral damage) as result.63 The United States is impotent to prevent a biological warfare terrorist attack against the population unless there is specific intelligence to forewarn of the attack.64 Additionally, following a biological warfare attack, there are many agents that medicine can't treat today.65 Given this discouraging information, the scenario described in the prologue seems even more plausible. Other "concepts of operations" are not hard to imagine. Nearly every grocery or drug store sells small aerosol deodorizers that periodically spray a fragrant mist. If an adversary wanted to neutralize the military brainstem of the United States, they might refill these deodorizers with a biological agent and clandestinely place one in each restroom in the Pentagon. After a few days, the entire population of the Department of Defense headquarters would be incapacitated, causing mass confusion and widespread terror. In a combat environment, conventional dispersal with bombs, artillery, or even aspraying device on an aircraft (like a crop duster) would not be nearly as effective as a more surreptitious attack that would infect people before they donned protective clothing. An infiltration by special operations forces or undercover operatives to place

aerosol canisters similar to insect bombs or deodorizers might cripple a force before it knew it was attacked. Like the Indians at Fort Ticonderoga, the force would fall ill and many would die. The force's ability to conduct effective combat operations would certainly be negated. By the time doctors diagnosed the disease and determined the right antidote, if there were one, the war could have been lost. Consider the implications if the Aum Shinri Kyo had used botulinum toxin or Anthrax instead of the Sarin chemical agent in their attack on the subway system in Tokyo. The death count and the magnitude of the terror would have been higher by orders of magnitude. There may have been as high as a 90 percent fatality rate instead of 0.2 percent actually experienced—that could be nearly 5,000 dead innocent civilians! And considering that the volume of Sarin to saturate a given area is approximately equivalent to 10,000 times the amount of botulinum toxin needed to cause the same effect, the attack could have been vastly more devastating.66

In another recent real-world incident, consider how much more effective the terrorist bombing of the New York World Trade Center would have been if they had placed a fire extinguisher filled with a biological agent at the bottom of each stairwell and rigged them to begin spraying just as the bomb ignited. In the ensuing panic, thousands of occupants of the building escaped down the stairs. No one would consider a fire extinguisher out of the ordinary in a crisis situation after the bombing. As a result, potentially every occupant in the World Trade Center could have been infected. If the intent of the terrorists had been to demonstrate how vulnerable the population of the United States is, the addition of biological agents to the conventional attack would really have terrified leaders and other citizens in the United States.

These incidents of potential biological terrorism must raise concern and questions about civilized society's ability (or more accurately, inability) to deal with such an eventuality. As we enter the twenty-first century, we may well be facing weapons of mass destruction used, not on the battlefield by warriors but among dense population centers by deranged non-nation states—a sobering prospective. Clearly, more has to be done to overcome this dramatic vulnerability—and soon.

Resolution

Biological terrorism is a challenge for the diplomatic, technical, military, medical, and intelligence communities, but the political arena may hold the biggest stick to deter biological warfare aggression. The BWC is the international vehicle to prevent biological proliferation. Unfortunately, it does not provide for verification or punitive measures.67 With the blatant violations of Russia and Iraq, much tougher verification protocols and stronger teeth must be built into the BWC. This is especially challenging given that the dual-use technology that produces biological agents gives the biological warfare producer an almost built-in plausible deniability. The technical community has the greatest and most urgent challenge to develop effective detectors, both on the battlefield and in biological agent detectors similar to metal detectors. This effort

should be a top priority. There should also be technological exploration, in concert with the intelligence community, for means to detect clandestine biological production facilities. The state-of-the-art must be pushed to find some means to detect a production facility with certainty, no matter the size. Both human intelligence and the national technical means must be greatly improved.

The military challenge is to train and equip to respond to a detected biological threats. To respond on the battlefield, militaries must develop effective, comfortable, and long-wearing protective clothing to replace the existing ensemble. A self-contained, air conditioned unit would be ideal. The military must also be capable of responding to a more strategic biological warfare threat—the production facilities and stored munitions. Planners must work with the technology community to develop a capability to bomb a biological warfare target and destroy the viability of the agents before they can be brought to bear on friendly forces and without causing unacceptable levels of collateral damage. For obvious political reasons, such precision-guided munitions should, also, be kept non-nuclear. The military also should hone its special operations, direct action skills for the biological (as well as chemical and nuclear) mission. The special operation option may be a more plausible alternative, depending on the scenario. The medical community should continue to work on biological warfare vaccinations that are broad-based, safe, and in sufficient quantities to inoculate those people most susceptible to biological warfare attacks. This daunting task will be even more challenging given the controversy about the vaccines administered during Desert Storm and their suspected connection with the Gulf War Syndrome.68 Doctors should also strive to improve the post-attack treatment in terms of rapid diagnosis, effective medical treatment, and a responsive surge capability to administer to large numbers of biological warfare-exposed patients. The intelligence community must be strengthened and sensitized in its efforts to gather data on the biological warfare threat. More resources should be directed toward identifying biological warfare threats by human and national technical means. This is especially important to deter terrorism in the interim until human intelligence and national technical means can provide more definitive answers about who are the haves and have nots. Finally, United States and allied political leadership should articulate a clear retaliatory policy against the use of any weapon of mass destruction. This was an effective deterrent on both sides during the cold war, and it appears to have deterred Saddam Hussein during Desert Storm. Perhaps even more importantly, this policy must be supported by unrelenting resolve to actually carry out the retaliation. Since countering BW is an issue that crosses many government agency borders, the direction of the effort should come from a multi-agency steering group. This steering group initially should include principals or primary deputies from the Office of the White House, Department of Defense, Federal Emergency Management Agency, Public Health Service, Central Intelligence Agency, and Department of Justice. Well- versed technical and operational advisors will be essential to steer the effort. Many of these agencies already have ongoing programs, but there is little senior-level cohesion to these fragmented endeavors. Additionally, some of these efforts have demonstrated blatant parochialism. A multi-agency steering group would overcome these stovepipe attitudes and efforts, placing emphasis on

national interests and prioritizing accordingly.

Conclusions

Biological warfare has been a threat for decades if not centuries. Yet the United States is ill-prepared to defend against or counter it—why? One view is that "the United States has a tendency to wish the problem would go away because it seems too unsavory and too difficult to handle."69 Another skeptic says, "We don't need it [BW defense] because we have a treaty."70 It seems the real issue is the apparent imbalance between demonstrated threat versus resources expended to meet that biological warfare threat. In the case of biological warfare, the fixes are technically difficult and they will not be low-cost. Weigh this against a threat that has not yet fully manifested itself. It almost seems logical that decision makers would be reluctant to spend scarce resources against a heretofore invisible threat. However, the United States is moving toward a more aggressive counter-BW program. In February 1995, the White House published a national security strategy that said: U.S. forces must be prepared to deter, prevent and defend against their use. The United States will retain the capacity to retaliate against those who might contemplate the use of weapons of mass destruction, so that the costs of such use will be seen as outweighing the gains. However, to minimize the impact of proliferation of weapons of mass destruction on our interests, we will need the capability not only to deter their use against either ourselves or our allies and friends, but also, where necessary and feasible, to prevent it. We are placing a high priority on improving our ability to locate, identify, and disable arsenals of weapons of mass destruction, production and storage facilities for such weapons, and their delivery systems. To minimize the vulnerability of our forces abroad to weapons of mass destruction, we are placing a high priority on improving our ability to locate, identify and disable arsenals of weapons of mass destruction, production and storage facilities for such weapons, and their delivery systems.71

This is a step in the right direction, but it needs to be a giant step. The biological warfare threat looms. The United States must have the capability to detect, preempt, and protect before someone strikes us or our allies with a poor man's nuke.

Epilogue-9 January

This is a CNN special report live from the Anthrax Task Force Center Miami. This morning, the fatality count was 16,437. This grim figure was just given to us by doctors here. Unfortunately, they say the number is going to increase dramatically because so many patients are close to death right now. Doctors are working frantically to save as many as possible, but they are running out of antibiotics and facing massive overcrowding. The halls are crowded with gurneys, and relatives are being asked to wait outside unless their loved one is critical. And

there are many of those.
The Anthrax Task Force was quickly assembled on the sixth of January after doctors across the nation diagnosed the horrible epidemic as pulmonary anthrax. The Federal Emergency Management Agency heads the team that consists of representatives from the FBI, the Center for Disease Control, the Armed Forces Military Intelligence Center, and the US Army Research Institute of Infectious Diseases, to name just a few. They are warning anyone who attended the Orange Bowl on New Year's Day to seek medical attention immediately. If you are experiencing cold-like symptoms, you are probably infected. Do not hesitate, or it will be fatal. The FBI reports that this appears to be a deliberate act of mass murder. But that is all they have been able to determine. They are offering a ten million dollar reward for any information about this horrendous crime.
This is all from Miami. Back to CNN News Headquarters.•

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Twenty-First Century Germ Warfare

Lt Col Robert P. Kadlec, USAF

The United States military is entering "one of those rare historical periods when revolutions happen in how wars are fought. The revolution derives not from any single invention or idea, but from a range of rapidly developing technologies."1 Some ten military revolutions have occurred since the fourteenth century.2 Advances in sensors, communications, stealth technology, and precision munitions have preoccupied those leaders planning how the United States will wage future wars. The revolution in biotechnology, however, has gone relatively unnoticed. The same technology and expertise which has brought revolutionary medical therapies and greater agricultural productivity is readily transferable to the development of biological weapons. Many technical barriers that once limited the effective use of biological warfare (BW) are gone. A country or group with modest pharmaceutical expertise can develop BW for terrorist or military use. As the United States prepares itself for the national security challenges of the twenty-first century, it must grasp the implications of this silent revolution. Nature has long waged its own form of biological warfare. The epidemic of bubonic plague killed an estimated one quarter of Europe's medieval population (25 million deaths) between 1347 and 1351. The introduction of smallpox into the New World by European explorers decimated the population of Native Americans.3 A pandemic of Spanish flu may have killed 50 million people worldwide between 1918 and 1919.4 By the year 2000, 40 million people could be infected by the Human Immunodeficiency Virus (HIV) which causes the Acquired Immunodeficiency Disease Syndrome (AIDS).5

Such events as these undeniably change biologic, economic, and political systems. Governments, groups, and individuals who desire weapons of mass destruction (WMD) can use biotechnology to achieve this goal. Skeptics mistakenly dismiss the military or strategic value of biological weapons. These weapons represent a credible threat to United States security and future economic prosperity. Biological warfare offers an adversary unique and significant advantages because of its ease of production, potential impact of use, and the ability to exploit US vulnerabilities. It is the only weapon of mass destruction which has utility across the spectrum of conflict. Using biological weapons under the cover of an endemic or natural disease occurrence provides an attacker the potential for plausible denial. In this context, biological weapons offers greater possibilities for use than do nuclear weapons. Biological warfare can include the use of bacteria, rickettsia, viruses, and toxins to induce illness or death in humans, animals, and plants. In the current public opinion, there is a significant misperception that clouds BW discussions. Biological warfare is often lumped together with chemical weapons. In BW, the types of agents, physiologic effects, methods of protection and detection, and methods of application are distinctly different from those of chemical warfare (CW).

Chemical Warfare Versus Biological Warfare

Biological agents are many times deadlier, pound-for pound, than chemical agents. Ten grams of anthrax spores could kill as many people as a ton of the nerve agent Sarin.6 There are four distinct types of chemical weapons: nerve, blister, blood, and incapacitating agents. The effects from these chemical agents can occur within seconds of exposure as in the case of nerve and blood agents or as long several hours in the circumstance of low-dose blister agent exposure such as mustard gas. The physiological and medical effects of CW are limited to well-defined symptom complexes. The outcome of each exposure is dose-dependent death or incapacitation.

Of the four general types of biological warfare agents mentioned, 60 have been identified with potential weapon utility against humans.7 The medical effects of biological agents are diverse and are not necessarily related to the type of agent. Some cause pneumonia. Others can cause encephalitis or inflammation of the brain. Each one causes a different complex of symptoms, which can either incapacitate or kill its victim. The ineffective dose required to induce illness or death may be as great as tens of thousand of organisms as in the case of anthrax, or just a few as with tularemia. With the exception of exposure to a toxin, a period of several days or even weeks may pass before the onset of symptoms and the ultimate effect. This incubation period is the time necessary for the microbe or viral agent to establish itself in the host and replicate.

Toxins, on the otherhand, are a product of living organisms and behave similar to chemical agents. Botulinum toxin is the most toxic substance known to man. Without supportive care, inhalation of nanograms (10-9 milligrams) of this agent will cause progressive muscular paralysis leading to asphyxiation and death.

Hazards and Protection

The risk posed by chemical agents has two components: a vapor and liquid hazard. An individual is protected from the vapor and liquid hazard of CW with the combination of a protective mask and the Mission Oriented Protective Posture (MOPP) suit. The United States also possesses an array of chemical point detectors and alarms which provide real time warning of exposure or attack. In contrast, the hazard posed by biological agents is primarily an inhalational one. The most effective means of delivering a BW agent is via an aerosol in the one to five micron particle size. Creation of this type of an invisible aerosol cloud may be efficiently accomplished using an agricultural sprayer for example. The current US military protective mask, when properly fitted and donned, affords virtually 100 percent protection. Biological agents generally do not pose a cutaneous hazard. A MOPP suit is not required. When US troops deployed to Saudi Arabia during Operation Desert Shield, they did not have an operational capability to detect any biological agents.8

During Desert Storm, the United States fielded only a rudimentary developmental detector system. This system could detect only two of several possible Iraqi BW threats. In addition to the limited scope of this detector, it took between 13 and 24 hours after the attack to determine the presence and identify the BW agent. There was no capability to provide any real-time or advanced warning of a biological attack.9 During the Gulf War, the first likely indication of an attack was ill and dying soldiers.

Biological Warfare Detection and Medical Protection

Detection of biological agents is a complex problem. Since World War II, attempts by the United States to develop BW detection have met with frustration and only limited success. Given the chemically indistinguishable organic properties of biological agents, the methodology for detecting chemical agents is not useful by itself. Each prospective BW agent requires a specific assay to detect and identify. Advances in medical diagnostics and biotechnology are allowing science to overcome these technical obstacles. The number of potential agents, however, and the demanding technical and developmental requirements make the challenge of BW detection daunting. In lieu of detection or advanced warning and the opportunity to don protective masks, medical products such as vaccines, immunoglobulins and antibiotics can mitigate the effect of biological agents and the potential operational impact. All three types of products can provide both preexposure and postexposure protection to an infectious disease and therefore a BW agent. Vaccines are active immunization measures whereby the host is intentionally exposed to either an attenuated or inactivated form of the disease causing agent. Vaccines prompt the body to produce antibodies which can afford a high level of protection for many years. The current Food and Drug Administration (FDA) approved vaccine against anthrax has been shown to be protective against inhalational agents in nonhuman primates.10

Like biological weapon detectors, vaccines are highly specific for a potential threat agent. In addition, the time needed to develop a safe vaccine product suitable for human use may be 10 to 15 years. While several BW vaccines exist for known threat agents such as botulinum toxin and tularemia, they remain in a status short of full FDA approval known as an investigational new drug (IND). Full FDA approval may be slow in coming if there is not sufficient test data on human response to the vaccines or if there is a lack of commercial demand or no perceived near-term public requirement for its use. Vaccines against exotic infectious disease agents associated with offensive BW fall under the purview of the Department of Defense with the Army as research and development executive agency. The ability to provide IND products, which are shown to be safe in humans and efficacious in animal studies, short of war or national crisis is limited by the need to satisfy the human use or informed consent requirements. These requirements specify the need to inform the prospective recipient of possible known and theoretical, short-term and long-term effects of the product. The stigma attached with IND status may have limited the use of the vaccine during Desert Storm. The controversy surrounding Persian Gulf Illnes (PGI) further negatively effects perceptions

of IND products used for military purposes. To date the biological warfare vaccines have not been associated with PI. Once a vaccine is given, there is lag time before adequate protective antibodies develop. The length of time and the number of doses of vaccine required before protection is attained and its duration, are unique characteristics of the specific product. Furthermore, a sufficiently high dose of a BW or infectious disease agent can overwhelm any vaccine. Finally, the protective level obtained for a population is not uniform. There is individual variability.
Immunoglobulins are existing antibodies which can be harvested from humans or animals. Like vaccines, they are protective for a specific agent. Unlike vaccines, which stimulate active production of antibodies by the host, immunoglobulins are considered passive immunization. When injected into a host, they provide short-term protection which usually lasts weeks or months. Immunoglobulins are usually used to protect viral and toxin agents. The rigorous FDA approval required for vaccines is also required for immunoglobulins. A well-known example of an immunoglobulin preparation is the serum used for Hepatitis A. Immunoglobulins currently exist for pre-exposure and post-exposure treatment of botulinum toxin intoxication. Developments in monoclonal antibody technologies offer the potential for rapid development of immunoglobulin preparations for use in BW medical defense.11 Finally, the use of antibiotics for pre-exposure or post- exposure treatment of bacterial or rickettsial BW agents offers the potential for broad spectrum-agent protection. Antibiotics however do not prevent or treat illness due to viral or toxin agents. There are further practical theoretic limitations to the use of antibiotic. Certain microbial infectious diseases and BW agents have a natural resistance to different antibiotics. Furthermore, antibiotic resistance among microbes occurs naturally or can be developed deliberately. Deliberate resistance can be induced by exposing cultures to serial exposures of ever-increasing doses of an antibiotic or by transferring a piece of genetic material which confers antibiotic resistance.12 It is possible to purposefully develop a BW agent that is resistant to a range of different antibiotics.
The duration of protection afforded by antibiotics depends on the amount of antibiotic available and the compliance of the individual to take them. For certain bacterial BW exposures, antibiotics may have to be taken for more than 30 days to prevent illness and possible death.13 A large enough infective dose of a bacterial or rickettsial agent could, as in the case of the vaccine, overwhelm the protection afforded by antibiotics. The medical means to mitigate the effects of BW agents and attack are imperfect. Even with reliable detectors which provide real time or advanced warning, vaccines, immuno-globulins, and antibiotics play a complementary role in the passive defense against BW. In the absence of BW detection, medical products represent the cornerstone of protecting US forces from the effects of BW. Besides their medical benefit, their administration may deter an enemy from using BW.

Role of Intelligence and Medical Defense

The need for a prior knowledge of BW agent threats for both detectors and medical products has already been suggested. A great deal is known about US offensive BW

agents developed and produced until 1969 (Table 2).

Table 2
US OFFENSIVE BIOLOGICAL WEAPONS AGENTS PRODUCEDBETWEEN 1954-1969

Antipersonnel
Anthrax
Brucellosis
Q Fever
Venezuelan Equine Encephalitis (VEE)
Botulinum Toxin
Staphyloccal Enterotoxin
Anticrop
Wheat rust
Rye rust
Rice blast

There are some classical BW agents which Japan, the United States, and possibly the former Soviet Union and Iraq have researched and developed as weapons.14 Anthrax and botulinum toxin fall into this category. Among the 60 other potential BW agents, "sound and complete intelligence data" will play a vital role in ascertaining which ones proliferants will pursue.15 Robert Gates, then director of the Central Intelligence Agency (CIA), underscored the problem in January 1992, when he cited human intelligence as being critical in assessing the proliferation of both chemical and biological weapons in the third world.16 Congress has not missed the importance of intelligence in focusing R&D. Congressional law mandates that BW defensive medical efforts be funded and prioritized based on a threat list developed by the US intelligence community.17

Two questions emerge from this process. The first is whether adequate priority and resources have been focused on collecting and analyzing BW-related intelligence and how successful these efforts have been. The second is whether the process of creating a threat list based entirely on intelligence assessments is adequate. Assessing an adversary's current BW efforts may ignore developments in biotechnology which may offer breakthrough capabilities and novel agents.

Weaponizing BW

The final distinction between chemical and biological weapons involves the methods of dissemination. Weaponizing of CW and BW implies three essential elements: agent, munition, and delivery system. Both can be "weaponized" into conventional munitions such as artillery rounds, cluster bombs, and missile warheads.

Unlike CW, BW weaponizing implies the efficient aerosolization of viable agents in a

one-to-five micron particle size. Dissemination of BW agents by conventional munitions pose certain technological difficulties, because they are sensitive to environmental stresses. Excessive heat, ultraviolet light, humidity and oxidation decrease their potency and persistence.18 The United States overcame these difficulties in the late 1960s to produce, weaponize, and stockpile several BW agents.19 Weaponizing BW includes some unconventional delivery systems which may put the United States at risk.20 In contrast to chemical agents, biological agents could also be easily adapted for use with commercially available agricultural sprayers. This dissemination method lends itself to both covert and clandestine applications and possible terrorist use.21 Unmanned remotely piloted vehicles (RPVs) with spray tanks represent another low-observable means of BW delivery.22 A common characteristic shared by both chemical and biological agents is their dissemination on ancient meteorological conditions. The prediction and control of the environmental dispersion of BW agents represents the greatest uncertainty about their use. Ideal conditions would occur at night, with favorable mild to moderate winds. The relative coverage of 1,000 kilograms of nerve agent Sarin is 7.8 square kilometers under these meteorological conditions. Attacking a major metropolitan city like Washington, D.C., would result in an estimated 3,000 to 8,000 deaths. A similar attack using 100 kilograms of anthrax under the same conditions would cover 300 square kilometers and result in 1 to 3 million deaths.23 Anthrax, under favorable meteorological conditions, could kill as many people as a comparably sized nuclear device.24

The Current Biological Warfare Threat

A recently published Office of Technology Assessment (OTA) document, Proliferation of Weapons of Mass Destruction: Assessing the Risks,25 had three major findings.

1. The states most actively working to develop WMD, although limited in number, are for the most part located in unstable parts of the world—the Middle East, South Asia, and the on Korean Peninsula.
2. WMD proliferation poses dangers to all nations. It poses particular problems for the United States.
3. The breakup of the Soviet Union presents immediate threats to the global nonproliferation regimes.

The proliferation of nuclear, biological, and chemical weapons and ballistic missiles creates a pall over the potential achievement of a stable global environment. It also raises the risks of escalation of regional conflicts. Proliferants understand the value of these weapons for deterrence, coercion, and war fighting. The consequences of their use have unfortunately been recorded in recent history. The horrific images of Hiroshima and Nagasaki leave little to imagination regarding the death and destruction that occur with a nuclear detonation. Similarly, the television images of dead Kurdish villagers and incapacitated Iranian soldiers during the Iran-Iraq War reveal the grisly and inhuman effects of chemical weaponry. The psychological impact

of Iran's Scud missile attacks on Israel and Saudi Arabia was enormous. Nowhere in recent history, however, has the use of BW been similarly documented. The suspicion that "Yellow Rain" or the mycotoxin tricothecene was used in Indochina has never been conclusively proven, to the embarrassment of the Reagan administration. Similar suspicions have proven inconclusive during the Soviet Union's occupation of Afghanistan. The former Soviet Union has only recently admitted the truth about an accident at a biological agent production facility in Sverdlovosk in 1979. Boris Yeltsin, himself, recently disclosed Russia's violation of the Biological Weapons Convention in 1992. During the 1990–1991 Gulf War, Iraq was suspected of having an extensive BW capability, but subsequent UN inspections failed to find any definitive proof. However, under the pressure of economic sanctionIraq admitted that it had a biological warfare R&D effort. For example, Iraqi officials have now disclosed that between 1985 and 1991 Iraq produced two germ warfare agents, baccilus anthracix and botulinum toxin.26 In some measure, BW has attained the stature of the "bogey man of WMD"—terribly feared but never seen. That fear and the threat, however, are real. According to the commander of the US Army Chemical and Biological Defense Agency (CBDA), the biological threat has been recently singled out as the one major threat that still inflicts catastrophic effects on a theater-deployed force. Desert Storm solidified the perception in the United States, in the Congress, and among our military leadership that biological weapons were something that third world nations considered a potential equalizer.27 Had Iraq used anthrax or botulinum toxin, enormous casualties would have resulted which would have overtaxed the Army's theater medical system.28

Certain findings of the OTA assessment relating to BW are noteworthy. The ease and cost of developing and producing BW is much simpler and cheaper than developing nuclear weapons. Biotechnology allows small facilities to be capable of producing large amounts of biological agents. Ten million dollars allows a proliferant to produce a large arsenal.29 The scientific and technological knowledge needed to develop and produce offensive agents in significant quantities is readily available and relatively unsophisticated. The equipment required is widely available and is dual-use, having legitimate commercial applications. Finally, and probably most importantly, the use of BW could be difficult to prove in some cases since outbreaks of endemic or naturally occurring disease happen.30 Eight nations have been implicated in developing offensive BW capabilities: Iran, Iraq, Israel, North Korea, China, Libya, Syria, and Taiwan.31 A ninth, Russia, admitted to developing an offensive program in violation of the Biological Weapons Convention, although it has reportedly ended such activities. The aforementioned list may not be all inclusive. Given the ability to produce militarily significant quantities of BW agents (kilograms) in small legitimate facilities, a committed proliferant with a "modestly sophisticated pharmaceutical industry" could develop a credible undetected clandestine offensive BW capability.32

Genetic engineering is not expected immediately to herald the development of new or exotic BW agents. Instead, its impact may enhance the environmental stability of existing BW agents. It has also been speculated that cloning DNA segments from

toxin-producing organisms may allow for the mass production of these agents. Production of protein molecules such as human insulin has been demonstrated and is commercially available technology.

Nonproliferation and Counterproliferation Policy

The fall of the Soviet Union signaled the end of the superpower rivalry and created an opportunity to establish an international system that seeks to ensure political stability, economic opportunity, and collective methods of conflict resolution. The United States has prioritized its national security objectives to enhance economic growth and development; to prevent the proliferation of nuclear, chemical, and biological weapons; and to resolve regional conflicts. Nevertheless, among aggressive third world states, WMD proliferation is occurring, and there are strong incentives to pursue BW versus nuclear or chemical weapons. Proliferants obtain significant capabilities with minimum economic costs and political risks. The 1991 Gulf War highlights this point. The United States and United Nations claimed after the war that Iraq had an advanced BW program, although public proof was lacking and Iraq initially denied this. During the war, Iraq capitalized on the coalition bombing of a "baby milk facility" for propaganda purposes. Despite US official claims that the Abu Gharyb infant formula plant was a dual-use facility capable of producing biological weapons, CNN's Peter Arnett's visit to the site and report raised public doubts about whether this was a legitimate allied target, when, in fact, it was. Following the war, intrusive on-site visits by UN inspectors failed to uncover any irrefutable evidence of an offensive BW program, although the Iraqis later admitted they had procured large quantities of a biological agents—anthrax and botulism toxin. The Iraqi experience shows that biological warfare programs can exist and be hidden within legitimate facilities. Even with direct on-site visits the likelihood of discovery may be small unless the visitors know precisely where to go and are permitted entry. The existence of such programs can be enhanced with tight security and deception. Recent events in the former Soviet Union concerning possible proliferation of nuclear materials also add greater uncertainty to the BW proliferation calculus. The potential impact and availability of scientists and technicians associated with the former Soviet offensive BW program should be considered. Aspiring proliferants may see them as lucrative recruiting targets. Unlike the complex technological requirements for nuclear weapons, one or two individuals with experience in BW agent production and weaponization could provide breakthrough assistance to a fledgling program. The challenge for the United States is to develop a coherent and coordinated strategy to limit BW proliferation. If this fails, the United States must be prepared to deter, preempt, and defend against it. On the basis of the several incentives presented earlier, the likelihood of preventing further proliferation or rolling back existing BW-capable nations seems unlikely. The simple arithmetic of the number of countries suspected of offensive BW activities is at nine and likely to increase by the end of the century.

Recommendations For The Future

How do we meet the BW threat in the twenty-first century? What policies will help solve the likely BW challenges? How should the United States counter-BW programs be prioritized and integrated? Intelligence Incomplete or absent intelligence about a suspected proliferant's BW program is a likely source of trouble. Not having specific information about the status of a BW program, or locations of production and storage, or methods of delivery, or the specific agents could result in an incomplete assessment. This could directly impact the development of United States strategy, policy, and capabilities to meet the threat. A comprehensive anti-BW intelligence effort must collect information relating to the basic science, medical, and bioengineering capabilities of a potential proliferator. Short of having reliable human intelligence with direct access to an adversary's BW program, this type of information is required to assess the biological capability of that nation.

Intelligence collection and analysis are critical for future United States BW counter-proliferation efforts. Determining the intent to develop BW, locating suspect facilities, and assessing the nature of the offensive program are essential elements of the intelligence effort. The importance of specific BW agent intelligence for medical and detection capabilities deserves emphasis. Even if the intelligence community collects and validates this information, there may be a significant lag time, years or even decades, before safe, effective counter-measures can be developed and fielded. Intelligence about the anticipated means of delivery and its doctrine of use is also important. This information allows development of US active defense capabilities to interdict and destroy delivery vehicles. Facility-related intelligence also allows for identification and targeting of production and related facilities for counteroffensive strikes. The ability to identify BW-related organizations and proliferants is important to optimize the utility of export controls and the ability to interdict shipments of related equipment destined for suspected BW countries or organizations. The ability to focus limited diplomatic and economic resources to dissuade, pursue arms control, and bring international pressure on suspected proliferants is, therefore, also intelligence-dependent. The likelihood that national technical means can identify any or all of the three key BW intelligence components— intent, location, and nature—is small. Dual-use facilities may not emit characteristic signatures, but still be capable of producing military significant quantities of biological agents. As alluded to earlier, the availability of human-source intelligence will be a critical element in providing information related to BW proliferation. Assessment of BW-related information requires trained personnel experienced in matters relating to biology, biotechnology, medicine, and agriculture. Balancing the technical component of the intelligence analysis process is the need to integrate the expertise and experience the intelligence system. Because of the greater relative intelligence challenges and the myriad of related areas associated with BW versus nuclear proliferation, adequate resources must be applied to the problem. Increasing collection priorities should also necessitate a concomitant increase in the analysis resources devoted to the problem. There should be an assessment and if necessary a redistribution of assets to reconcile the disparity between the effort

against nuclear proliferation and that of BW.

Policy and Strategy Development

Beyond the collection and assessment of intelligence, policy development and integration of the many functions are required to respond to BW proliferation. The domestic vulnerability to covert or clandestine acts of BW terror should be assessed. There must be executive-level interest and involvement to oversee the development of a crisis response system to domestic BW incidents. While the federal response to terrorist acts is well delineated, the time-sensitive health care demands created by an act of biological terror must be assessed. It is beyond the scope of the single agency identified in the Federal Emergency Response Plan, the Department of Health and Human Services, to mount the necessary reaction to deal with the health consequences and prevent unnecessary loss of life.

A historical example illustrates the scale of the effort required to respond to an act of BW terror in a major metropolitan area. In 1947, an

American business man traveled to New York City from Mexico City. During his bus ride, he developed a fever, headache, and rash. Though ill upon his arrival in New York, he went sight-seeing. Over a period of several hours, he walked around the city and through a major department store. His illness, smallpox, progressed and he died nine days later. As a result of this single case, 12 other cases of smallpox and two deaths occurred. Because of smallpox's ability to be transmitted from person to person, this handful of cases was deemed so serious by public health officials that 6,350,000 persons in New York City alone were vaccinated in less than a month.33 Unlike 1947, Americans have not been routinely vaccinated against smallpox since 1980. A significant proportion of the US population is susceptible to this virus. The number of cases expected to occur as the result of a deliberate act could be in the thousands or tens of thousands. Even though the World Health Organization declared smallpox eradicated, North Korea has been identified as one possible country retaining cultures of this virus to use as a biological weapon.34 Even if a noncontagious agent were used, the public health consequences could be overwhelming. If several kilograms of an agent like anthrax were disseminated in New York City today, conservative estimates put the number deaths occurring in the first few days at 400,000.35 Thousands of others would be at risk of dying within several days if proper antibiotics and vaccination were not started immediately. Millions of others would be fearful of being exposed and seek or demand medical care as well. Beyond the immediate health implications of such an act, the potential panic and civil unrest created would require an equally large response. Local law enforcement agencies would be overwhelmed and would need the assistance of state and federal agencies. The complete vulnerability of the United States if exposed to this type of terrorism would prompt other terrorists to attempt the same type of attack for extortion or additional terror impact. Prior to a domestic incident such as this, a capable, practiced, and coordinated response mechanism must be in place. The Federal Emergency Management Agency (FEMA) provides this coordination function, but its actual familiarity and practice associated with biological terrorism is not known. The health-related support functions found in the Departments of Health and Human Services,

Veterans Affairs, and Defense would have to be integrated into a single response plan. Stockpiles of necessary antibiotics, immunoglobulins, and vaccines would have to be procured, maintained, and be readily available to administer within hours after recognizing an incident. An additional critical element of this response would be the management of information to allay fears and avoid unnecessary panic. The effort required to respond to a biological act of terror rivals that needed for an accidental or deliberate detonation of a nuclear device.

Arms Control

The BWC clearly represents the "lock which keeps the honest man honest." It serves a vital function by establishing an international norm against BW proliferation. Efforts should be made to provide both disincentives and incentives for current states to comply with the BW treaty. Nonsignatories should be leveraged to participate in the convention. Strengthening the BWC by enhancing transparency of biological activities is stated US government policy. Measures identified in the third review conference are being examined for use in a possible formal protocol. Like the warning to consumers—caveat emptor, subscribers to the convention must understand that complete verification is not just elusive but impossible. During the original proposal of the BWC by the United Kingdom, the Soviet military strongly opposed any limitation on offensive BW. The Soviet Foreign Minister Andrei Gromyko felt that, for propaganda purposes, a prohibition on biological weapons would be useful. Without international controls, the Politburo and the Soviet military both endorsed the "toothless" convention in 1972.36 The Soviet Union was one of the three depositories of this treaty. Recent disclosures by President Boris Yeltsin regarding former Soviet and Russian violations of the Biological Weapons Convention highlight the limits of that treaty.

The opportunity to strengthen the regime must also be tempered by events in Iraq since the Gulf War. Despite intrusive inspections, no concrete evidence of its offensive BW program has been uncovered, although Iraq has admitted to an R&D effort prior to the war. The continuation of the US sanctions is now solely dependent on Iraq's refusal to detail their BW program. Public statements by senior US intelligence and government officials indicates that Iraq retains its offensive BW capability. Indeed, there is a strong suspicion that Iraq may not have destroyed its BW agents as it has claimed. A disturbing prospect for strengthening the BWC is that the 21 measures identified in the third review conference were utilized in Iraq including such actions as monitoring, sample collections, short-notice visits, record reviews, and interviewing of key personnel. These measures have yielded no conclusive evidence to date about the present Iraqi BW capability or its past program. Diplomatic Measures and International Pressure Current DOD counterproliferation policy emphasizes use of public diplomacy, positive and negative security assistance, and identifying the economic, political and military costs of proliferation. Denial of certain equipment or technologies used in BW is problematic. Export controls, interdiction, or disruption of supply networks will have limited impact given the dual-use legitimate nature of the Diplomatic efforts to prevent or control BW proliferation will have similar limits. States that are parties to the BWC, but are committed eventually to developing secret offensive biological weapons capabilities, can do serious BW research and

development legally for a time within the current treaty framework. Nations who are not signatories can refuse entry and pursue offensive programs as well. Given the low likelihood of detecting violations, nonsignatories could take advantage of economic incentives or foreign assistance programs for joining the BWC, yet pursue clandestine offensive BW programs. There are reasonable indications that diplomacy alone can do little to prevent BW proliferation. Nevertheless, diplomatic and economic pressure can serve a useful purpose in inhibiting a proliferant's activities by invoking sanctions, export controls, or publicly disclosing violations. One must realize that invoking these measures depends on timely and accurate intelligence. Diplomatic measures which try to control proliferation may, in the short run, delay a proliferant's efforts. In the long term, they may motivate determined proliferants to conceal or deceive their true intent and activities. Of course the perfect solution to proliferation is correcting the underlying reasons why nations choose to develop biological or nuclear weapons. Clearly, BW is a symptom of a deeper security need.

Countermeasures Once proliferation occurs and an adversary attains an offensive BW capability, the focus changes to mitigating its perceived advantage and deterring its use. The range of counteroffensive capabilities and strategies must include deterrence, preemption, and destruction. During Desert Storm speculation occurred regarding the implicit use of nuclear weapons in response to BW attack. Both President George Bush and Secretary of Defense Richard Cheney publicly stated that any attack on
US forces with chemical or biological weapons would be met with "massive retaliation." The accuracy and credibility of this policy option are
subject to much debate. Determining the culpable party after a covert or clandestine BW attack has occurred may be impossible. The circumstances following the bombing of Pan American Flight 103 highlight the potential difficulties of a forensic investigation following an act of terror. Before implicating Libyan intelligence operatives, both Iran and Syria and several terrorist groups were suspected. Finding a "smoking gun" and proving who is responsible for a future covert biological warfare attack could be difficult or impossible. There will be times in the future when the US president may have to consider military preemptive strikes against a terrorist state or group to protect the United States and allied governments against BW attacks. Preemptive activities or anticipatory self-defense can range from efforts that occur during nonhostilities to open armed conflict. The recent interception and attempted interdiction of precursor CW materials bound for Iran from China (Yin He incident) present a recent example. The 1981 bombing of the Iraqi Orisak nuclear reactor by Israel is representative of using overt military force during instances short of open armed conflict. On the other hand, the US air campaign sought to destroy Saddam Hussein's WMD capabilities in the opening days of the Gulf War. Destruction of the means to produce, process and deliver biological weapons is the final element of the counteroffensive strategy. There is a potential risk of collateral damage when striking BW-related facilities or delivery systems. Theoretically, a downwind hazard could
occur if bulk storage of BW agents were struck when meteorological conditions were favorable to their dissemination. While no specific confirmed reports of collateral

damage were documented during Desert Storm, there was one news report that implicated the occurrence of illness and death in Iraqi guards at an unidentified BW facility south of Baghdad after coalition bombing.37 Another partial answer to the BW threat would be to deploy theater ballistic missile defenses capable of intercepting enemy BW warheads while enroute to their targets. Ideally, interception and destruction would occur during early boost phase of the enemy missile launch to lower the risk of friendly casualties. Good ballistic missile defenses are not enough, since the United States and its allies must also respond to the challenge posed by future enemy cruise missiles equipped with biological weapon warheads. Of course, such missile defenses are defenses of the last resort. The greatest probability of minimizing collateral damage would be realized if special forces or other means of preemption allowed the United States or its allies to destroy the enemy BW capability prior to an adversary filling the weapon or launching the attack.

Biological Defense

The last element of the BW counterproliferation strategy is medical and nonmedical passive defensive measures. The importance and problems of BW detectors have already been identified. A priority effort exists to develop and field a BW detector which can provide stand-off warning and real-time detection of attack. Another nonmedical defensive measure that deserves emphasis is the employment of collective protective systems. Hardened shelters and work areas for rear-echelon troops as well as filtered over-pressurized systems for combat vehicles, ships, and planes could minimize the effects of both chemical and biological weapons. Medical measures to protect against biological threats include short-term and long-term methods of protecting US military forces. Even when detectors become available, medical measures will play an important role in both protection and treatment against BW attack. Efforts should be focused first on developing, testing, and producing Food and Drug Administration-approved vaccines to immunize soldiers against the most likely BW threat agents. The availability of suitable vaccines and other medical products must remain a priority. On 26 November 1993, Undersecretary of Defense William Perry signed the DOD immunization policy for BW threats. It establishes the requirement for both peacetime and contingency use of vaccines against validated BW threats. Each theater commander-in-chief (CINC) is required to determine the regional threat and provide the chairman of the Joint Chiefs with requirements. Integral in meeting the regional CINC's requirements is the development of a DOD-dedicated vaccine production infrastructure. The liability concerns of the US pharmaceutical industry have affected development and production of public health vaccines. The controversy associated with the liability risk of immunizing children against Pertussis is illustrative. Congress mandated a government-subsidized fund to defray court awarded damages resulting from severe neurologic sequelae from the Pertussis vaccine. The rationale behind this effort was to protect the vaccine companies from large cash awards resulting from litigation, so to preserve their profitable production of important public health vaccines. The commercial or public need for vaccines against biological warfare agents short of an act of terror is virtually zero. Yet, should a high-confidence warning of an attack on our population occur, substantial amounts of these products would be necessary to

respond to minimize illness and death. The peacetime military need exists as result of the DOD immunization directive. The ability and desire of the pharmaceutical industry to commit its facilities for dedicated vaccine development are questionable in light of profit and liability concerns. A US government vaccine facility has value for both BW and public health considerations. Such a facility should remain a high priority project in developing capability to respond to BW proliferation. Besides the actual protective effect gained by BW vaccines, certain elements of deterrence can be garnered by minimizing the effect of an adversary's BW agent. Immunizing US forces and having the ability to protect others will minimize an enemy's ability to coerce the United States and its allies. They will also lessen the potential impact of a BW attack on the United States or its allies. Therefore, the perceived or actual benefit derived by the BW proliferant will be lessened. Finally, vaccines and medical countermeasures can contribute the means to maintain the war-fighting capability of US military forces as well as providing for the survival of US citizens.

Conclusions

The proliferation of biological warfare weapons offers less developed nations a capability as lethal and potentially devastating as a nuclear device. The ease and relative low cost of BW production, coupled with spread of dual-use legitimate biotechnology, will facilitate and accelerate BW proliferation in the short-term and well into the twenty-first century. Biological weapons can be employed in noncombat settings under the guise of natural events, during operations other than war, or can be used in open combat scenarios against all biological systems—man, animal, or plant. Deliberate dissemination of BW agents may be afforded possible denial by naturally occurring diseases and events. The low probability of detecting the development and production of terrorist and militarily significant quantities of BW agents lessens the effectiveness of diplomatic measures such as dissuasion, denial, and international pressure. The limitations associated with treaty verification leave little optimism for the long-term effectiveness of the Biological Weapons Convention. Ascribing to the BWC may offer further potential of plausible denial if proliferants sought to use membership as a cover for their prohibited efforts. Expectations for preventing BW proliferation must be grounded in reality. The likelihood of preventing or deterring a determined proliferant from obtaining biological weapons is relatively small. The outlook for the future of biological weapons proliferation is discouraging. "Brain drain" from the former Soviet Union may create volatile opportunities for breakthrough proliferants. Future US policies against BW proliferation need to be based on integrated government policies and capabilities to deter, preempt and defend against this threat. No single element of the program is adequate to deal with the BW problem. Together, however, these elements can lower the risk and mitigate the potential impact of BW. In addition, the problem of biological warfare cannot be narrowly focused on its ability to kill or render people ill. Biological warfare's potential to create significant economic loss and subsequent political instability with plausible denial exceeds any other known weapon. Germ warfare at the end of the twentieth and inception of thetwenty-first

century directly threatens the security of the United States and the achievement of a peaceful, prosperous, and stable post-cold war era.

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ANTHRAX

Biological Warfare Defense Information Sheet

General information:

The disease Anthrax is caused by the bacteria Bacillus anthracis. Anthrax is normally found in sheep, cattle and horses but can be transmitted to humans who contact infected animals or their products. Usually humans acquire the disease by skin contact with the bacteria or by inhaling the bacterial spores found in sheep wool. As an agent of biological warfare (BW), it is expected that a cloud of Anthrax spores would be released at a strategic location to be inhaled by the personnel under attack. As such, the symptoms of Anthrax encountered in BW would follow those expected for inhalation of spores,as opposed to those expected for skin contact or ingestion of the bacteria. These symptoms are discussed in the sections below.

Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water). Spore destruction requires steam sterilization.

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents.

Symptoms:

About 1-6 days after inhaling Bacillus anthracis spores there would be a gradual onset of vague symptoms of illness such as fatigue, fever, mild discomfort in the chest and a possibly a dry cough. The symptoms would improve for a few hours or 2-3 days. Then, there would be sudden onset of difficulty in breathing, profuse sweating, cyanosis (blue colored skin), shock and death in 24-36 hours. These symptoms are essentially those of Woolsorter's disease, which is caused by inhalation of Bacillus anthracis spores rather than contact with the bacterium through the skin. Contact through the skin is the most common "naturally" occurring form of Anthrax and is characterized by swelling and boils on the skin. Skin symptoms would not necessarily be expected with Anthrax resulting from inhaled spores in BW.

Medical countermeasures:

There is a licensed human Anthrax vaccine that consists of a series of six doses with yearly boosters. The first vaccine of the series must be given at least four weeks before exposure to the disease. This vaccine protects against Anthrax that is acquired through the skin in an occupational environment. It is believed that it would also be effective against inhaled spores in a BW situation.

For unvaccinated individuals, antibiotics are given if the individual is exposed to Anthrax. Pencillin is the drug of choice. Antibiotic treatment is known to lessen the severity of the illness in workers who acquire Anthrax through the skin. Inhaled Anthrax was formerly thought to be nearly 100% fatal despite antibiotic treatment, particularly if treatment is started after symptoms appear. A recent Army study resulted in successful treatment of monkeys with antibiotic therapy after being exposed to Anthrax spores. The antibiotic therapy was begun one day after exposure. This study implies antibiotic therapy may be useful in a BW setting if begun soon after the attack.There is no evidence of person-to person transmission of Anthrax. Quarantine of affected individuals is not recommended. Anthrax spores may survive in the soil, water and on surfaces for many years. Spores can only be destroyed by steam sterilization or burning, but not by disinfectants. An infection of local animal populations such as sheep and cattle could follow a biological attack with spores. Infected animals could then transmit the disease to humans through the human's skin, mouth or nose. Veterinarians should be made aware of this possibility. Local health officials should take appropriate measures (published elsewhere) to prevent Anthrax outbreak among animals and an ensuing human epidemic.

Botulism

Biological Warfare Defense Information Sheet

General Information:

The disease "botulism" may be familiar as a hazard of eating improperly canned and undercooked foods. Botulism is caused by a toxin of the bacteria Clostridium botulinum. Botulism toxin is one of the most toxic substances known. It acts by inhibiting nerve impulses and produces progressive paralysis often leading to death if untreated. Specific symptoms are discussed below. Although botulism is normally acquired from food, it is expected that as an agent of biological warfare (BW) it would be dispersed as a toxic cloud to be inhaled by the persons under attack. Although it is possible that a terrorist might sabotage food or water with botulism toxin, a toxic cloud is a much more likely route of delivery in BW.

Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water).

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents.

Symptoms:

There are 7 types of botulism toxin but all produce similar symptoms. Symptoms may begin about 24-36 hours after exposure, but there is evidence that symptoms may be delayed up to several days if the toxin is inhaled instead of ingested. Symptoms are characterized with a progressive paralysis from the head down with the individual remaining otherwise mentally alert and awake. The first symptoms of paralysis are drooping eyelids, dry mouth and throat, difficulty talking and swallowing, blurred and double vision. Muscle weakness progresses from the head down, eventually leading to a paralysis of the muscles used for breathing. If not treated, botulism is fatal in 60% of cases because of inability to breathe. Symptoms may progress to this point in as little as 24 hours from onset.

Medical countermeasures:

Antitoxins for use after exposure to botulism are available from the Center for Disease Control (CDC) or the US Army Medical Research Institute of Infectious Disease, depending on which type of antitoxin is needed. The antitoxin is based on horse serum so potential recipients should be tested for sensitivity to horse serum before starting the vaccination series. Antibiotics are not effective in treating this intoxication.Medical measures such as mechanical ventilation (breathing) can reduce the expected fatality rate from 60% to 5% of those who exhibit symptoms. Recovery in such cases may require weeks or months of intensive nursing care.

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PLAGUE

Biological Warfare Defense Information Sheet

General information:

To most people the disease "plague" is familiar in a historical sense as the Great Plague or Black Death which occurred in Europe, Asia and Africa in the 1300's. This form of plague is known as bubonic plague and still occurs in the word today, but less than twenty cases would typically be reported in the U.S. in one year. Bubonic plague is caused by the bacterium Yersinia pestis and is normally carried by rats and their fleas. It can be transmitted to humans by the bite of a flea. Bubonic plague in humans is characterized by a 2-8 day incubation period followed by sudden onset of a high fever, chills, swollen, possibly red lymph nodes particularly in the groin area (called buboes) and death in 2-4 days if not treated. There is another form of plague, pneumonic plague, in which the plague organism is inhaled from infected cats. In the case of biological warfare (BW) it is expected that the attacker would try to induce pneumonic plague in humans by releasing a cloud of Yersinia pestis bacteria.Pneumonic plague transmitted in this way can be fatal in one to a few days if not treated immediately.

Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water).

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents.

Symptoms:

After inhaling the plague organism there would be an incubation period of up to three days followed by sudden onset of high fever and coughing up of blood. Pneumonia would be evident on a chest X-ray. The pneumonia would progress rapidly producing inability to breathe, failure of the circulatory system and death in a few days. Buboes would not be expected to appear in pneumonic plague resulting from BW.

Medical Countermeasures:

A vaccine is available for bubonic plague, but its usefulness in the case of pneumonic plague is unproven. For bubonic plague prevention, the vaccine is given in a series of doses. At least three doses need to be given during a 4-7 month time period before exposure to plague for the vaccine to be effective. Booster vaccines must be given every six months for 18 months and then every 1-2 years for the vaccine to remain effective.

Antibiotic treatment for those exposed to pneumonic plague is available but must be begun within 24 hours of the start of symptoms to be effective. Streptomycin,

tetracycline, and chloramphenicol used early are highly effective. People who come face-to-face with a pneumonic plague sufferer must also be treated with antibiotics whether they have symptoms or not. Chemoprophylaxis of close contacts can be accomplished using tetracycline (15-30 mg/kg) or sulfonamides (40mg/kg) daily in 4 divided doses for one week.

Human to human transmission through the air is possible in pneumonic plague: therefore, strict hospital isolation procedures should be followed as far as practical in the BW environment.

Q Fever

Biological Warfare Defense Information Sheet

General information:

Q fever is a disease normally found in sheep, cattle, goats and ticks. The cause of the disease is Coxiella burnetii, a bacteria-like agent known as a rickettsia. Humans acquire Q fever by inhaling the rickettsia which become airborne during handling and processing of animals. As an agent of biological warfare (BW), Q fever is an incapacitating agent and would not be expected to cause significant fatalities. It would likely be distributed as a cloud of rickettsia that would be inhaled by personnel under attack. Rickettsia are highly infectious when delivered in this manner.

Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water).

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents.

Symptoms:

Symptoms appear about 10-20 days after the Q fever rickettsia are inhaled. The symptoms resemble flu symptoms and include fever, chills, headache, fatigue and muscle aches. About one half of persons with symptoms will have pneumonia evident on chest X-ray and some of these will have a cough or chest pain. The complications of meningitis or and inflammation of the heart may arise, but these are uncommon. Normally, the duration of Q fever is 2 days to 2 weeks at which time the disease resolves without permanent effects on the individual.

Medical Countermeasures:

The symptoms of Q fever usually resolve without antibiotic treatment. Antibiotics can be given to shorten the illness. Tetracyclines are the drugs of choice, some recent work indicates ciprofloxacin may also be useful. The timing of antibiotic therapy is important. If given 1-8 days after exposure, the antibiotics will merely delay the symptoms for about three weeks. Antibiotics begun 8-12 days after exposure and continued for 10 days will prevent Q fever from occurring.

Q fever is not usually transmitted directly from person to person, so quarantine of affected individuals is not suggested. Q fever has, however, been transmitted through blood or bone marrow donations, so health providers should be aware of this possibility.

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RICIN

Biological Warfare Defense Information Sheet

General information:

Ricin is a toxin made from the mash that is leftover after processing Castor beans for oil. Castor bean processing is a worldwide activity: therefore, the raw materials for making ricin are easily available. Additionally, ricin is easy to produce and is stable. Ricin is toxic if inhaled or ingested. In biological warfare (BW) it is expected that ricin would be released as a toxic cloud. It could also be injected into specific persons as a terrorist or sabotage weapon.

The toxic effects of ricin occur because it kills the cells of the body that it contacts when it is taken into the body. Upon inhaling an adequate amount of ricin, death of persons affected would be expected in 36-48 hours because of difficulty breathing and circulatory system effects. Ingested Ricin is expected to cause internal bleeding, death of vital organs and death of the individual. Injected Ricin causes death by major organ failure.

Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water).

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents.

Symptoms:

Human experience with ricin is scanty. The prediction of symptoms to be expected is based on animal studies and accidental human exposures which were not fatal. Symptoms would probably vary depending on whether ricin was inhaled, ingested or injected. About three hours after inhaling ricin, the symptoms expected are cough, tightness of the chest difficulty breathing nausea and muscle aches. This would progress to a severe inflammation of the lungs and airways, increased difficulty breathing, cyanosis (blue skin) and death in 36-48 hours from failure of the breathing and circulatory systems.

Ingestion of ricin would be expected to cause nausea and vomiting, internal bleeding of the stomach and intestines, failure of the liver, spleen and kidneys and death of the individual by collapse of the circulatory vessels. No specific affects on the lungs and airways would be expected.

If injected, ricin causes marked death of muscles and lymph nodes near the site of injection and probable failure of major organs and death of the individual.

Medical Countermeasures:

There is currently no vaccine available to be given before exposure to ricin although vaccines are under development by the U.S. Army. There is no ricin antitoxin to be given after exposure; therefore, the only treatment available involves management of the effects based on the method of exposure to the toxin. If ricin is inhaled, oxygen may be given as well as drugs to reduce inflammation and support the function of the heart and circulatory system. Persons requiring these,treatments would be gravely ill.

Ingestion of ricin would treated by emptying the stomach and intestines of their contents and replacing lost fluid. It is not known whether these measures would be lifesaving.

There is no specific treatment for injected ricin other than making the person comfortable and using any measures normally used to treat organ failure. Recovery would not be expected if an adequate dose of ricin were injected.

Protective measures:

The military chemical protective mask is effective against inhaled ricin. Future protection efforts are aimed at developing a vaccine against inhaled ricin.As a toxin, ricin acts directly on the individual exposed to it and is not reproduced within the individual: it cannot be passed from person to person. Quarantine of affected individuals would be of no value.

Staphylococcal Enterotoxin B (SEB)
Biological Warfare Defense Information Sheet

General Information:

Staphylococcal toxins are produced by the bacteria Staphylococcus aureusand are normally acquired through ingestion of improperly handled food. There are several related staphylococcal toxins which cause symptoms usually recognized as "food poisoning." Staphylococcal toxins can also cause illness if inhaled in low doses. The toxin interacts with the individual's immune system to produce a variety of effects. In a biological warfare (BW) situation, it is expected that a toxic cloud of a type B staphylococcal enterotoxin would be released near the target personnel. Symptoms of inhaled SEB differ somewhat from those of "food poisoning. These symptoms are discussed below. The sabotage of food and/or water with SEB thought to be a possibility for terrorist attack

Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water).

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents. .

Symptoms:

Symptoms of inhaled SEB would be expected to appear 3- 12 hours after exposure and would consist of sudden onset of a high fever of 103-106 degrees F., chills, headache, muscle aches, a dry cough and possibly an inflammation of the lining of the eyelids. In a few cases there may be difficulty breathing, chest pain and fluid in the lungs. The fever would last 2-5 days The cough may persist up to four weeks. Although SEB is not expected to produce many fatalities, it could incapacitate 80% of personnel in the area of attack. In rare cases, the effect of the toxin may be more severe, leading to shock and death.If the toxin is swallowed, there may be nausea, vomiting and diarrhea with no symptoms involving the lungs.

Medical Countermeasures:

No vaccine or antitoxin is available to treat SEB before or after exposure. The treatment for SEB once symptoms appear consists of pain relievers and cough suppressants. Additional drug therapies are under investigation. For severe cases which are expected to be rare, more extensive hospital procedures may be needed such as mechanical breathing and replacement of fluid.

As a toxin, SEB acts directly on the person who inhales or ingests it and is not an "infection" which is reproduced inside the body. It cannot be passed from person to person, so isolation of affected individuals is not necessary

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Tularemia

Biological Warfare Defense Information Sheet

General Information:

Tularemia is caused by the bacteria Francisella tularensis. Normally this disease is transmitted to humans by contact with animals, particularly game animals and by the bites of flies and ticks. Contaminated meat and water are also a source of infection. Francisella tularensis can enter the human body through the skin, mouth, eyes or nose. In biological warfare (BW), it is anticipated that the bacteria would be delivered as a cloud to the target population, making entry through the airways into the lungs the most common route, although ingestion and entry through skin wounds is also possible. The disease may appear as ulcer or lesion at the place of entry and then progress to the lymph nodes and through the blood to other organs, including the lungs if the lungs are not already infected. The fatality rate is about 5-15% if untreated.

Francisella tularensis can remain alive for weeks in water and soil. It is highly infectious in that a very small number of bacteria can cause disease. Disinfection of contaminated articles may be accomplished using a 0.05% hypochlorite solution (1 tbps. bleach per gallon of water).

The military chemical protective mask is effective against inhalation of all Biological Warfare Agents.

Symptoms:

The symptoms of tularemia may vary depending on the method of entry into the body. As stated above, the main route of infection in BW is expected to be inhalation. After 2-10 days, symptoms, such as fever, chills, fatigue, chest discomfort, dry cough and weight loss, would appear. Pneumonia may be evident with a chest X-ray. There may or may not be swollen lymph nodes. The infection may progress from the lungs to the blood and other organs.

If the bacteria enter through a wound on the skin, a skin eruption will usually appear at the sight of entry, but not always. There will most likely be swollen lymph nodes, fever, chills and headache. Pneumonia may also be present. If the bacteria enters through the eye, there will be an inflammation of the lining of the eyelid and associated fever, chills, etc. If the bacteria are ingested the symptoms will be nausea, abdominal pain, vomiting and diarrhea. With antibiotic treatment, tularemia is only fatal in 1-3% of cases.

Medical countermeasures:

Once a person is exposed to tularemia, antibiotics can be given effectively whether or not symptoms have appeared. Streptomycin is the drug of choice; gentamicin and

tobramycin are also effective. Antibiotic therapy should be continued until temperature is normal for 4-5 days. As stated above, recovery is expected in all but 1-3% of cases. Human to human spread of the disease is rare, so those infected do not need to be isolated. However, where skin ulcers are apparent, these should be treated with hospital wound secretion precautions.

THE NUCLEAR THREAT

Dick Ward
Criminal Justice International

How real is the threat of a nuclear terrorist attack on a major city somewhere in the world? That the question is being asked in government offices and intelligence agencies throughout the world is in many ways beyond belief for most of the public. Although the current threat is considered small, a large number of intelligence professionals believe it is just a matter of time before the unthinkable happens. A common theme in the discussions centers on the ability of one of the major "outlaw" powers to contract with a terrorist cell to carry out a nuclear- based attack. The countries most identified with such a threat include Iran and Iraq, but intelligence experts point out that North Korea, Syria, and Libya are possibilities, as are any number of terrorist groups throughout the world. And given the success of attacks on the World Trade Center and the Federal building in Oklahoma City, as well as the recent arrest of the Unabomber suspect, there is growing concern that a small group or an individual could pose a significant threat.

The most significant obstacle is the difficulty in acquiring the quantities of plutonium-239 or highly enriched uranium which would be necessary to create a one kiloton bomb. The expertise necessary to construct such a device is relatively rare, but it is believed that there are enough disaffected scientists available to hire such a bomb-maker. The most likely source of nuclear materials is believed to be the former Soviet Union, where Russia and several of its former states currently control large numbers of weapons which could be used to provide the main component of a nuclear bomb. Since 1990 there have been about a half-dozen cases involving thefts and transport of nuclear materials. Almost all of these cases have involved uranium, beryllium (a metal used in making atomic bombs) or plutonium. There have also been a number of cases in which individuals offered to sell nuclear materials, but were either apprehended before the sale took place or were not actually in possession of the goods. Intelligence officials in Europe and the United States, as well as those in Russia, are expending a significant amount of time and funds to cope with the threat but, as one pointed out, success depends on the ability to gather information from a large number of sources, and cooperation between countries is an important prerequisite. The Russian intelligence service works closely with Germany's Federal Intelligence Service and all indications are that they are making a serious attempt to prevent smuggling.

But Russia is not the only potential source. Currently the United States has almost 9,000 nuclear warheads, while France and China have under 500, and Britain has about 200. Several other countries, such as India, Pakistan and Israel are believed to have a nuclear capability. However, the levels of security in these facilities tends to be relatively tight.

A second obstacle to carrying out the threat involves transportation of the bomb or its components to the site. A one kiloton nuclear bomb could be transported in a small

truck or van. Here again, experts believe that the actual location where a bomb might be detonated is probably less important than the ability to get it into a country. A one kiloton bomb would virtually wipe out one square mile of a city, and its impact on the world would be devastating. Consider, for example, world reaction to the Oklahoma bombing, which was a conventional terrorist type bomb. Experts also cite the gas attack by Japan's Aum Shinrikyo sect as an example of how far at least one terrorist group was willing to go in sending a message. Police discovered documents in the sect's headquarters about uranium enrichment. There is disagreement among experts as to how easy it might be for a terrorist to fabricate ever a simple nuclear device, but many do agree that the expertise is in the hands of foreign powers. Whether or not an individual or a small group working alone could accomplish the task depends in large measure on the availability of materials and knowledge about the amounts to be used in the device. Information about how to make such a bomb is readily available on the Internet and in libraries. One book, the Los Alamos Primer: First Lectures on How to Build an Atomic Bomb, is available from the University of California Press. Considered to be one of the best guides to nuclear fission, according to reporter David Hughes, it is but one of many publications currently available on the open market.

What are the potential targets? Israel and the United States head the list, but virtually any country which is involved in some form of conflict could be a target. The probability of a small splinter terrorist group carrying out a nuclear attack is low, say intelligence experts, who believe that state sponsorship of such an attack would almost be a necessity. Further, a small group most likely would have to seek help, and this increases the chances of discovery. Counter-terrorism experts also seem to feel that public response to such an attack would be so negative as to generate cooperation from sources which otherwise do not cooperate with the police or military. "It would take a madman to do it," said one American official, "but we seem to have enough of them around these days."

In addition to intelligence, the most effective means to prevent a nuclear attack lies in security of available supplies of weapons-grade plutonium or uranium. The Atomic Energy Commission (AEC) in the United States has one of the tightest programs for protecting installations, but this is not the pattern around the world. A well engineered theft by a disgruntled scientist could be successful, even with safeguards. The possibility of theft is compounded by the availability of battlefield nuclear weapons, which have a smaller blast capability, and the use of weapons-grade uranium fuel in nuclear powered naval vessels, as well as in some power facilities.

The Department of Energy Nuclear Emergency Search team (NEST) has the responsibility of disabling a nuclear device if one is discovered, with the FBI having lead responsibility for investigations of terrorist activity. NEST team members consist of scientists, engineers and technicians usually affiliated with nuclear testing facilities, such as Los Alamos and Lawrence Livermore National laboratories. NEST teams are extensively trained in ways to disable a bomb, including ways to neutralize it without direct contact.

Robots, video cameras, and other technology is available in key locations throughout the United States.

While the threat is still considered minimal, many experts believe that the day will come when nuclear terrorism becomes a reality. Theodore Taylor, a retired nuclear weapons designer who was deputy director of the nuclear program in the Pentagon, maintains that the threat is real. In the 1970's he reportedly took author John McPhee on a tour of the World Trade Center, calculating that a low-yield bomb could bring down both towers and kill as many as 50,000 people.

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SMUGGLING SPECIAL NUCLEAR MATERIALS

Dr. A. Robitaille and Mr. R. Purver. May, 1995
CANADIAN SECURITY INTELLIGENCE SERVICE
Unclassified

Editors Note:
Ever since the collapse of the former Soviet Union, reports have circulated with increasing frequency concerning attempts to smuggle materials from that country's civil and military nuclear programs. Such an increase obviously raises a number of concerns (outlined in the authors' introduction), chief among which is the possibility that these materials might eventually fall into the hands of proliferant states or terrorist groups. Commentary this month is a co-authored issue: Dr. A. Robitaille was most recently the Director of Scientific and Technical Intelligence with DND; Mr. R. Purver, formerly Research Director at the Canadian Center for Arms Control and Disarmament, is presently a Strategic Analyst with CSIS.

Disclaimer: Publication of an article in the COMMENTARY series does not imply CSIS authentication of the information nor CSIS endorsement of the author's views.

Introduction

Attempts to smuggle special nuclear materials (i.e., those of significance to a nuclear weapon program) continue to increase throughout Eastern Europe. Further, available data reflect only those unsuccessful attempts which have been intercepted by the appropriate authorities. Troubling questions remain. How many other cases of such smuggling have been successful and remain undetected? To which countries are these materials being shipped? Why are such curious materials being offered up for sale? Is the risk to Western countries real and serious, or is it instead little more than a nuisance in international relations? Have the police themselves created an artificial demand through efforts to prevent it? Is there a genuine possibility that a rogue country like Iran might actually succeed in the construction of a clandestine nuclear weapon? Or worse yet, a terrorist organization such as Hamas? Some of these questions must, for the time being, remain unanswered, but others are worthy of consideration, and are discussed further below.

Significance of materials being smuggled

Reports of the trafficking of Red Mercury (claimed to have the composition Hg2Sb207) have been circulating for many years. Red Mercury was touted as a mediator in nuclear weapons design, particularly as an essential ingredient in pure-fusion weapons, a view expressed most recently in International Defense Review (6/94) by

Dr. F. Barnaby, a former Director of the Stockholm International Peace Research Institute. What is known about Red Mercury is that it was the Russian code name for the production of Li6D — a legitimate component of thermonuclear weapons, but not some mystical or magical ingredient for other purposes. In recent years Red Mercury has been widely discredited, and the "market" for it appears to be diminishing. Of the nearly 1000 known incidents of smuggling, all but a handful have been of isotopes or materials entirely useless to nuclear weapons manufacture, thus reflecting the technological ignorance of both the supply and demand sides of the "market". However, four prominent exceptions were of truly special nuclear materials and all occurred within the last eight months of 1994. In May 1994, six grams of plutonium — Pu239 (99.75% purity) — were found in the garage of businessman Adolf Jaekle, in the southern German village of Tengen. In another case, six people were arrested in June 1994 in the Bavarian town of Landshut with 0.8 gram of weapons-grade uranium — U235 — for sale. Although the isotopes were certainly weapons-grade, the quantities involved were fortunately minuscule. In August 1994 at Munich Airport, 350 grams of 87% pure Pu239 were discovered aboard a flight from Moscow, and three couriers arrested; 200 grams of lithium (Li6) were confiscated at the same time. Both of these materials are required in the construction of thermonuclear weapons, and the amounts are significant. In the case of the plutonium, this amounts to almost 10% of the fissionable material required in an (admittedly) efficient weapon design. Finally, in December 1994, in the largest seizure yet of weapons-grade uranium, Czech officials in Prague confiscated 2.722 kilograms of U235 enriched to 87.5%, and arrested three men later identified as "nuclear workers". As in the case of the earlier German seizures, the materials were believed to have originated in the former Soviet Union (FSU), although Russian authorities have stridently denied that any of their weapons-grade material has gone missing. Statistics on the overall incidence of nuclear smuggling vary according to the source, with some counting confirmed hoaxes or cases involving materials not generally considered harmful. Nevertheless, all appear to agree that the number of incidents is growing and represents a disturbing trend, especially in qualitative terms. For example, the New York Times in February 1995 cited a "Western European intelligence report" to the effect that the number of cases of actual or attempted nuclear smuggling from former communist countries reported to Western governments had more than doubled in 1994, to 124 from 56 the previous year and 53 in 1992. Furthermore, of the 1994 cases, a total of 77 had involved uranium or plutonium rather than "more harmless materials". For its part, the German federal criminal police (the BKA) recently reported that it had investigated no fewer than 267 cases of "illicit traffic in nuclear or radioactive materials" during 1994, compared to 241 in 1993, 158 in 1992, and just 41 in 1991. In short, the threat has clearly become serious enough that it can no longer be ignored or discounted.

Sources and smuggling routes

Ever since the breakup of the USSR, concerns have been expressed that fissionable materials from its civil and military nuclear programs would find their way onto the black market where they could be obtained by would-be proliferant states or even

terrorist groups. Such concerns have increased as economic conditions in the FSU have further deteriorated, with sagging morale in the military and insufficient (or non-existent) pay for workers in key industries and facilities, as well as the dramatic rise of organized crime. Russian authorities continue to deny that weapons-grade materials seized in the West originated in their country. They have, however, admitted the theft of substantial quantities of highly-enriched uranium within their own borders. For example, it was reported to an Interpol meeting in May 1994 that Russian authorities had arrested two persons the previous March in St. Petersburg in possession of 2 kg of U235 enriched to 98%, presumed to have come from a "nuclear plant" east of the Urals. Russian Interior Minister Viktor Yerin told an international crime conference in Naples in November 1994 that 80 crimes relating to the illegal traffic of radioactive substances had been committed in the previous two years, including 32 thefts, but that none of the material had been suitable for weapons and none of the thefts had been from a "defense complex". Other reports put the number of cases much higher, but tend to agree that most, if not all, thefts have involved civil rather than military installations. Finally, a British television report in February 1995 quoted Russian sources as saying that their federal counter-intelligence service (the FSK) had seized a total of 212 kg of uranium fuel stolen from nuclear plants, and 8 kg of weapons-grade uranium, during 1994.

By one estimate, there are 950 sites for enriched uranium and plutonium in the FSU, including research institutes, weapons laboratories, assembly plants, power plants, nuclear waste storage sites and naval fuel depots. In many cases, physical security measures are reported to be seriously inadequate, while the accounting is said to be so poor that authorities are unaware of the precise amount and nature of materials in their possession. For example, until recently, the Kurchatov Institute of Atomic Energy in Moscow, housing hundreds of kilograms of nuclear materials, had no inventory controls, portal-monitoring system, or adequate fencing. According to one American official, "there was nothing to stop thieves from backing up a truck and loading what they wanted". A Russian naval officer on trial in Murmansk for having stolen 4 kg of 20%-enriched U235 in November 1993 has described how he simply walked straight into a poorly guarded storage area in Severomorsk (headquarters of the Russian Northern Fleet), forced a padlock on a door, and walked out with several canisters of nuclear fuel rods. Such reports hardly lend credibility to the protestations of Russian officials that they have the situation under control.

As noted earlier, all but one of the cases of weapons-grade material seized in the West have occurred in Germany, while the number of other incidents there appears higher than in other countries. This has led to some skepticism about why smugglers would choose Germany as the preferred route, given its better criminal intelligence and more efficient police forces. One possible answer would be the availability of the large sums demanded by smugglers. However, the issue also intruded into the German federal elections in the fall of 1994, with the opposition charging that the problem had been exaggerated, and incidents actually manufactured to improve the image of the incumbent government and allow it to pass stricter security regulations. Seizures of

illicit nuclear materials have in fact been reported in a variety of other countries, including Switzerland, Poland, Turkey, Romania, the Czech Republic, Hungary, Bulgaria, Austria, Italy, Belgium, Sweden and India, as well as in the FSU. The Baltic states are said to be a preferred route for smugglers, given the laxity of their border controls. Many observers have pointed out that the FSU's southern borders are even more porous, and are in some cases directly adjacent to potential state customers, leading to speculation that there may be much greater—though undetected—traffic through Central Asia.

Potential customers

Hitherto it has been the conventionally accepted wisdom that the clandestine construction of a nuclear weapon was beyond the capabilities of individuals, terrorist organizations, or even smaller countries. This view has persisted since World War II, primarily because of the immense effort by the USA at the time to produce one non-deliverable nuclear device (Gadget) and two nuclear weapons (Little Boy and Fat Man)—an effort which required tens of thousands of dedicated workers, billions of dollars, the construction of two very large research establishments (Oak Ridge and Los Alamos), many smaller ones, and four years. If there is any lesson to be learned from the recent South African experience, however, it is that this perception no longer remains true, if indeed it ever did. South Africa's program was truly modest in scale, but was characterized by perseverance, patience and technical competence. In the beginning the program employed only about 100 personnel, of whom 40 were directly involved and only 20 actually in weapons construction. Even at the termination of the program (in 1989), a total of fewer than 300 were involved. At completion the program was designed to have the capacity to manufacture only two weapons per year—a production rate small enough to remain undetected by other countries. Secrecy was paramount; thus South Africa chose to make the program as self-reliant as possible, and depended little upon imported equipment. Most of the equipment which did have to be imported was not proscribed by international nuclear export controls, but in many cases did violate international sanctions imposed as a result of its policy of apartheid. What was required from foreign sources was the fundamental "intellectual infrastructure", and many of its key staff members were sent abroad (to the USA and Europe) for graduate education in the scientific disciplines required by the program. (A similar process was followed by Iraq, and unfortunately by many other countries attempting to develop weapons of mass destruction.)

Smuggled nuclear materials could be acquired either by states seeking a short-cut to a nuclear weapons capability (or an augmentation of existing stocks), or by terrorist groups. Given the technical difficulties encountered by a number of states in large-scale and relatively well financed efforts to acquire nuclear weapons, as well as the extremely high prices quoted for nuclear materials on the black market, many observers are skeptical about the likelihood of terrorist groups being able to acquire a nuclear explosive capability. However, radioactive materials—in much smaller

quantities—could be used for terrorist purposes to contaminate a water supply or render unusable a particular area or facility. Although some types of contamination may be more difficult to achieve than commonly believed, most analysts agree that, given the widespread public "allergy" to nuclear material in whatever form, the mere threat of such use of radioactive materials could be a potent terrorist tool.

A more likely destination for smuggled nuclear materials would be the weapons program of a nation-state. A sufficient supply of fissionable materials is usually considered the primary obstacle to a new state's acquisition of a nuclear weapons capability. The acquisition of smuggled material might also allow a state to forego the construction of plutonium production, reprocessing and/or enrichment facilities, thereby effectively concealing its program from outside eyes and achieving strategic surprise. Finally, the acquisition and transport of highly radioactive materials by ill-trained and/or ill-equipped smugglers may pose a serious public health problem, as evidenced by the controversy surrounding the seizure at Munich Airport. Sources in both Russia and the West maintain that, despite the apparent abundance of "sellers" in the nuclear black market, there appear to be relatively few "buyers" at the moment (other than journalists seeking a sensational story, or government undercover agents attempting to gauge the extent of the problem and to put a stop to it). Concern has been expressed that German authorities in their zeal to expose smugglers may have artificially created a market where none exists. German prosecutors have denied newspaper reports that the Spaniards arrested in Munich were suspected of having ties with the Basque separatist group ETA. Reports have persisted of documents showing that Saddam Hussein is trying to buy weapons-grade material on the European black market, and that a shipment of smuggled plutonium may have been sent to Pakistan. Iran, Libya and North Korea have also reportedly been named by German authorities as possible "buyers". However, the "Western European intelligence report" referred to earlier, as well as recent public remarks by senior American officials, suggests the lack of any conclusive evidence so far of the involvement of any foreign states in the trade.

International efforts to reduce nuclear smuggling

The seizures in Germany in 1994 prompted a flurry of diplomatic activity to come to grips with the nuclear smuggling problem. Initially, they also caused some acrimony in relations between Russia and its Western partners, with Moscow accusing the latter of seeking to place Russian nuclear programs and facilities under supranational control, or at least to gain unfair advantage in the international nuclear market. Nevertheless, on 22 August 1994, Germany and Russia signed a memorandum aimed at improving bilateral co-operation to prevent the smuggling of nuclear materials. This included the establishment of a "hot line" between the relevant authorities, the exchange of information on cases, the possibility of mutual participation in analyzing seized materials, and joint promotion of an international agreement on the prompt notification of future cases. Subsequently, the issue was discussed both between various Western

states and former republics of the Soviet Union, and in a number of high-level multilateral forums, including meetings of the European Union foreign and interior ministers, the International Atomic Energy Agency (IAEA), Interpol, and the new European police agency, Europol.

President Yeltsin moved to demonstrate the seriousness of his government's attempts to deal with the problem by announcing in late August 1994 the establishment of an inter-agency commission headed by Sergei Stepashin, director of the counter-intelligence service. Further, on 15 September 1994, Yeltsin issued a decree to improve the "system of registration, conservation and control of nuclear materials". Among other things, it called for a prompt review of the accountancy and physical security situation; designated Gosatomnadzor (GAN), the Nuclear Control Commission, as the supreme agency in this area, reporting directly to the president; and called for priority budgeting in the fiscal year 1995 budget. Nevertheless, reports have persisted of divisions within the Russian bureaucracy over the magnitude of the problem and the degree to which Western concerns should be accommodated. The most powerful player, the Ministry of Atomic Energy (Minatom), has been described as being "not at all helpful in this regard". At least part of the problem is the multiplicity of Russian agencies having control over fissile materials (unlike in the West), including Minatom, the Ministry of Defense and even the Ministry of Shipbuilding (in regard to naval reactor fuel). Moreover, suspicions linger about widespread corruption and involvement in the trade at the highest levels of the Russian bureaucracy. At their general conference in September 1994, the members of the IAEA expressed "deep concern" over the problem and called on Agency Director General Hans Blix to strengthen the IAEA's role in this area. The agency convened a meeting of 96 experts from 46 countries and 3 international organizations in Vienna in November 1994. They endorsed greater IAEA involvement in such matters as aiding states to improve their national systems of accountancy and control, as well as physical protection of materials; and developing a reliable data base on incidents to assist decision-makers and better inform the public. However, the availability of the necessary funds remains a problem. The United States has been a leader in publicizing the issue, regarding it as a severe threat to its own (as well as international) security. Until recently, however, the rather extensive Nunn-Lugar program for the "denuclearization" of the states of the FSU had failed significantly to improve fissile material protection, control and accounting in Russia, due in part to disagreements between the two governments. A laboratory-to-laboratory effort administered by the US Department of Energy in 1994 was more successful, leading to improvements by the end of the year at the Kurchatov Institute in Moscow. On 20 January 1995, Minatom agreed to co-operate for the first time with the USA in the physical protection and accounting of nuclear materials, beginning with six facilities. However, critics charge that the effort is still "too little, too late", given the gravity of the problem. Other related efforts by the USA and/or its allies aimed at least partly at preventing smuggling include the creation of International Science and Technology Centers (ISTCs) in Moscow and Kiev to provide support to former weapons scientists; and "Project Sapphire" — the November 1994 transfer from Kazakhstan to the USA of 600 kg of poorly guarded, highly enriched uranium (HEU).

Regarding the latter operation, however, one critic has pointed out that the material in question represented only .05% of the total amount of weapons-usable material in the FSU!

Long-term disposition of fissile materials

Approximately 500 metric tons of U235 and 300 tons of Pu239 from dismantled weapons and other sources must eventually be disposed of as a result of various arms control agreements currently being implemented in
the FSU. These materials represent a proliferation potential of some 60,000 nuclear weapons. In discussing options available to governments to deal with this problem, one must make a clear distinction, for technological reasons, between uranium and plutonium. Uranium is one of the most common elements found in the Earth's crust. It powers universally the 450-odd nuclear power plants currently operating in the world. There is already a well-established, legitimate, international market for the material. The fissionable isotope (U235) can, in principle, be readily blended-down with natural or depleted uranium (U238) to the same levels of enrichment as used in power-plant fuel. Once so diluted, the material is no more of a proliferation concern than natural uranium, since isotopic enrichment is an extraordinarily difficult process. On the other hand, plutonium does not exist in nature, and Pu239 cannot merely be diluted with other isotopes to make it proliferation-resistant. Blending-down with other elements is no solution either, since separation of the original plutonium would require chemical, rather than physical, processing which is, at least in principle, considerably less difficult. Finally, but not the least importantly, the word "plutonium" itself is so highly emotive that there are very few Western governments prepared even to discuss participating in its disposal, for purely political reasons. Yet the material exists, it represents a threat to the world and it must be dealt with. It is no wonder, therefore, that there has been a flurry of international activity among governments (West and East) to deal with weapons-grade uranium, for both political and commercial reasons, and such an aversion to dealing with the plutonium problem.

Uranium

On 28 August 1992, Russia and the USA agreed to transfer from Russian inventories 500 metric tons of weapons-grade uranium to the USA for dilution into reactor fuel over the next 20 years. Over the subsequent two years, much progress was made between the two countries towards resolving difficulties associated with this transfer, primarily having to do with the issue of "transparency"; namely, developing methods and procedures to ensure that neither country could surreptitiously divert any of this material back into a weapons program. (One wonders why either would ever want to, since they both have the same disposal problem and a serious over-supply of existing weapons.) In any event, the final Implementing Contract was signed on 1 January 1994 by Presidents Clinton and Yeltsin in Moscow. This contract, between the United

States Enrichment Corporation and Techsnabexport, has a value of (US) $12 billion. Regular shipments were to begin in late 1994, although some had been made earlier to develop and verify handling procedures. Thus, it can be reasonably assured that (barring thefts) the Russian stockpile of U235 will eventually be disposed of in an orderly way, with satisfactory material accounting and control procedures, and that there is little Canada can do to assist further in this effort.

Plutonium

The much more vexing question remains, however: what to do with 300 tons of highly radioactive, extremely toxic material that some would argue has no legitimate commercial value and is useful for little else than the potential production of 50,000 nuclear weapons? This issue has been on the table for some three years now, with little progress evident to date. As we have seen, a clandestine market is emerging to fill the void left by government inaction and ineptitude, and international tempers are becoming frayed as a result. Virtually all political leaders have recently emphasized the importance of dealing swiftly with the problem, to pre-empt potentially disastrous consequences, but it has led to little more than political posturing. Partly as a result of the recent controversy over the seizures of illicit material in Germany, a Siemens (Germany) initiative to build a mixed-oxide fuel plant in Russia (to burn up Pu as nuclear reactor fuel) has all but been killed politically, much to the consternation of German arms control authorities, who were vigorously recommending this option. At a much more rational level, the American government contracted with the National Academy of Sciences (NAS) to develop policy options to deal with the disposition of weapons-grade plutonium. The NAS final report was released on 24 January 1994 and did much to put the issue into its proper perspective. While public opinion has concentrated more on the ultimate fate of the material, the NAS chose instead to emphasize the short-term questions, which should be resolved as soon as possible to contain the menace. The NAS noted that nuclear weapon technology is so widespread now that access to information is no longer a substantial barrier to proliferation. Rather, the principal technical barrier is access to fissile material itself (a conclusion reinforced by the South African experience, discussed previously). The NAS recommendations included:

(1) establishing a reciprocal regime of monitored net reductions in the stockpiles of nuclear explosive material;
(2) agreeing on the methods and the locations of secure interim storage of nuclear-explosive material from dismantled nuclear weapons; and
(3) superseding interim storage as quickly as possible with measures to minimize the accessibility of the plutonium for re-use in weapons by the imposition of substantial radiological, chemical and logistic barriers.

Regarding the ultimate disposition of weapon plutonium, the NAS identified two leading options which could be implemented quickly to minimize present security

dangers (many others were discarded as requiring too much technological development before implementation, which would have introduced unacceptable delay). The two options that emerged practicable, commercially, reliably and safely, in the short term, were the following:

(1) the burning of mixed-oxide (uranium and plutonium) fuel in existing or future commercial nuclear power plants around the world. (For a variety of technological reasons the Canadian CANDU design is the best-suited of all the world's reactor types to burn plutonium, as already demonstrated at the Chalk River Nuclear Laboratories of AECL); and

(2) the mixture and glass-vitrification of plutonium with already processed, high-level radioactive waste.

Proponents of the first option point out that this would recapture some of the very substantial energy already consumed to produce the material initially, and that long-term storage of nuclear waste in glass-vitrified form has yet to be demonstrated satisfactorily. Proponents of the second option argue that this would render the material no more accessible than the plutonium already present in spent reactor fuel, and that any commercial use of plutonium is inherently bad since it might eventually lead to the legitimization of plutonium recycling and thus an enduring "plutonium economy". Nevertheless, both options are available and could begin to be implemented very quickly, if the political will would permit it.

Conclusions

There exists at the present time a dangerous quantity of fissile materials potentially available for the construction of nuclear weapons. The underlying economic and social conditions that make the FSU a particularly threatening environment in this regard are unlikely to change for the better in the near- or even the medium-term. Important elements of the nuclear infrastructure there are said to be resisting controls more intrusive than those already in place, which are widely believed to be grossly inadequate. As increasing numbers of nuclear weapons are dismantled under the terms of already negotiated arms control agreements (as well as unilateral reductions), hundreds of tons of additional fissile material will become available and subject to transport (where it may be most vulnerable to interception).

The only real technological barrier to the clandestine construction of nuclear weapons is access to fissionable material itself. There is a growing black market for this material, and eventually demand will result in enough material reaching as-yet unidentified buyers to produce a nuclear weapon, if the world community continues to procrastinate as it has to date. In the meantime, terrorist threats of contamination using radioactive substances gain enhanced credibility as the number of smuggling incidents continues to rise. Eliminating the menace will be difficult, especially

politically, but action must be taken sooner rather than later in order to minimize the short-term threat. Finally, Canada is very well placed, at least technologically, to make a substantial and an enduring contribution to world peace in this area, given resolute leadership.

The views expressed herein are those of the author, who may be contacted by writing to :
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Bomb Attacks in City Centers

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Massive explosions in London, New York, and other major cities worldwide clearly demonstrate that important financial districts have become prestigious targets for terrorist organizations, regardless of their motives. In addition to causing significant loss of life, these bombs can severely disrupt trade and economic transactions. Further, modern satellite communications broadcast grisly bomb scene images around the world within minutes, adding to the lure of this type of target for groups seeking media publicity.

The primary law enforcement objective must be to keep such incidents from occurring. However, as vividly revealed in London and New York, a democratic society with freedom of movement makes prevention difficult, at best. Therefore, police departments must be prepared to deal with the aftermath of bomb detonations in highly concentrated business districts to reduce deaths and injuries, to preserve the crime scene, to investigate the crime successfully, and to help local businesses recover quickly from the damage.

While the device detonated in New York's World Trade Center caused substantial problems, the injuries and damage undoubtedly would have been far worse and spread over a wider area if a similar or larger device had exploded in the street at the same time of day. Yet, the inevitable tightening of security within buildings will make the street bomb more likely in the future.

Within the past 2 years, two massive bombs rocked the streets of London's financial district. Terrorists used a truck to deliver the April 10, 1992, bomb that exploded in front of the Baltic Exchange. Just over a year later and only 200 yards away, a similar truck bomb exploded in front of Bishopsgate on April 24, 1993. Both devices contained homemade explosives consisting of ammonium nitrate fertilizer and sugar ignited by a commercial or military explosive, such as Semtex. Just as effective as military explosives, home-made explosives require more to get the same result. The bomb in Bishopsgate is estimated to have weighed between 2 and 4 tons.

Two aspects of the London explosions stand out: The scale of the damage, especially the amount of glass broken over such an extensive area--more than 400 meters (437 yards) in each direction--and the unpredictability of the blasts. The City of London Police learned lessons by dealing with these detonations that can help other cities prepare for such attacks. This article discusses how law enforcement can develop contingency plans for bomb incidents and prepare the business community for such a possibility.

DESIGNING A CONTINGENCY PLAN

When creating a contingency plan, police departments should take into account evacuation plans, pre- and post-bomb cordons, other emergency services, and changing bomb scene objectives. A thorough, well-rehearsed plan for coping with the aftermath of a detonation can help cities to reduce the devastating effects of a bomb, ensure maximum public safety, and return rapidly to normality.

Deciding Whether to Evacuate

When dealing with bombs in the street, London police previously had advised evacuation of the area in the face of a realistic bomb threat. However, significant problems prompted a revision of this advice. Difficulty in locating the bomb, the possibility of secondary devices (designed to attack police and placed where the terrorist believes police will rendezvous), unreliability of warnings (if given), unpredictability of detonation time, and the dangers of flying glass and debris make it prudent to include the option of not evacuating onto the street. After all, what is the point of evacuating people onto the street only to expose them to substantial injuries from flying glass, shrapnel, and falling masonry?

Instead, evacuation to previously identified safe areas within buildings away from glass, such as in basements, should be considered. This option proved itself when the Bishopsgate device was detonated, and persons near the explosion evacuated to a subbasement. Although shaken, occupants of the building sustained no serious injuries. In addition, experience has shown that a total collapse of buildings is unlikely, even for those structures close to the device.

Clearly, though, a direct threat to a building itself or a device planted within a building, as opposed to on the street, requires evacuation. It must be emphasized that only qualified structural engineers can give advice about safe areas. Not every building will have a suitable area, either in terms of safety or sufficient capacity, so evacuation planners should designate additional or alternate sites, if possible.

Pre-Bomb Cordons

Plans should be designed for both pre- and post-bomb cordons because the requirements differ. Pre-bomb plans assume the luxury of prior knowledge of the device, either through its discovery or a warning. Because warnings can be unreliable, extreme caution should be exercised. For example, London police received a warning about the Baltic Exchange bomb, but the tipster incorrectly placed it one-quarter of a mile from its actual location.

In the London Police Department's experience, large car bombs in the street require a minimum cordon of 400 meters (437 yards), or more than the length of four football

fields. An explosion can cause injuries and damage even beyond this distance, so everyone should exercise caution near the perimeter. Considering this scale in the center of any city, the enormous difficulties encountered with pre-bomb cordons become apparent.

Occupants of the danger zone should be warned immediately so they may seek a safer location. Yet, to effectively warn the vast number of people in a large business area poses an insurmountable problem to police because people are bound to be missed. However, improvements in the warning mechanisms that require minimum input from police to reach the maximum area can help. The City of London Police has implemented two new warning systems--one high-tech and one surprisingly traditional. First, the city established a dedicated pager system to warn people simultaneously throughout the city. Building managers or security officers can rent pagers that receive messages from police about suspected bombs. The messages indicate the device's location and size, if known, so that the recipients know whether their building is at risk and what precautionary measures to take.

Second, officers on the beat carry whistles again. Radios had replaced whistles some time ago, but when police tried to shout warnings to pedestrians, everyone ignored them. The loud, piercing sound of whistles, however, attracts attention and reaches farther, enabling more people to hear the warning.

Post-Bomb Cordons

The chaotic aftermath of a bomb presents a different set of considerations. Damage from bomb explosions usually covers a vast area, necessitating both inner and outer cordons. The outer cordon marks the farthest extent of the damage and serves safety and security purposes. After the blast, tons of glass fall and continue to fall, often from great heights, presenting the most hazardous effect of the explosion. For example, at the Baltic Exchange bomb site, workers cleared 500 tons (1 million pounds) of glass shards and debris from the street. Glass and fragmentation cause most of the injuries, and therefore, should be foremost in the minds of those responsible for preparing contingency plans.

Several other factors impact the placement of the outer cordon. In addition to the street-level destruction, damage occurs to underground railway systems, electric and gas lines, sewer and water pipes, and telecommunications systems, either as a result of the initial blast or the subsequent ground shock. Vibrations from subway trains and from aircraft passing nearby can dislodge debris, adding to the hazards of the bomb scene, as could weather conditions. In terms of security, many offices, shops, banks, jewelers, etc., are blown open and become easily accessible to thieves.

The inner cordon marks the most severely damaged area and the crime scene. Officers must determine the extent of the crime scene as quickly as possible so that it can be preserved properly. As soon as it is considered safe, police must search this

area thoroughly to recover bomb and vehicle parts and as much other evidence as possible. Of course, detectives may find some parts of the bomb outside of the crime scene area as well.

Emergency Services Coordination

The whole thrust of the response must be multiagency coordination, with all components (police, fire fighters, rescue workers, public works officials, and structural engineers) working in unison toward one goal--restoring normality. In the United Kingdom, the initial response to all such incidents, from train wrecks to bomb explosions, is the same, although the demands on the agencies will vary according to the different scenarios.

For every incident, the police control and coordinate the response, from initially ensuring public safety through the final stages of investigation. Not trained or equipped to fight fires, deal with casualties, or advise on structural safety, the police must assist those who perform these duties. Regular meetings of all agencies working at the scene ensure that everyone works in unison.

Bomb scenes in the city immediately become hard-hat areas because of the damaged buildings. As a safety measure, all emergency services need to work under the advice of the local authority structural engineer, in coordination with the police. Use of heavy equipment to clear streets and shore up buildings should not occur until approved by local authority engineers. If these individuals are not readily available, recovery from the incident most likely will take much longer. Fire and rescue teams must be able to access the area immediately. Therefore, although not a first priority, police must handle the traffic situation quickly, establishing alternate routes to ensure that emergency services can get to and from the scene and the hospitals. As the dust settles, tremendous pressure comes from business owners to return to their premises as soon as possible. Indeed, in the zone between the inner and outer cordons, i.e., outside of the crime scene but inside the damaged area, the main aim should be for the dislocated tenants to resume responsibility for their own office space. To limit chaos at the scene, officials must plan carefully for the tenants' return and work closely with other services, taking into consideration safety and crime scene demands.

Changing Objectives

Primary concerns are to rescue casualties, to set up cordons, to evacuate everyone from within the inner and outer cordons, to preserve the inner cordon as a crime scene, and to institute traffic diversions. Yet, these objectives change as the incident gradually comes under control.

The emphasis shifts to making buildings safe and clearing the streets, minimizing cordons, minimizing traffic diversions, and returning tenants to their premises. As the objectives are achieved, the requirements for emergency services at the scene will be

reduced. The area can be handed over gradually to city administrators to organize the structural recovery and to service the needs of the community for alternative accommodations, interim communications systems, etc. Contingency plans should prepare for the changing concerns in order to help make the transition safely and efficiently.

PREPARE THE BUSINESS COMMUNITY

While local authorities must be prepared to respond to bomb incidents, so should businesses that could be affected. Police, in conjunction with local authorities, should educate business owners and building managers and help them to develop individual contingency plans. Establishments located in potential target areas should prepare and practice contingency plans to deal with both pre-bomb and post-bomb incidents. Businesses should be made aware that film on windows and properly designed net curtains provide added protection and may reduce injuries. Many emergency requirements apply to incidents other than bombs, such as fires, but it is critical to stress the differences as well. For example, there must be no confusion that fire procedures will always require evacuation, whereas bomb plans might not. Major problems will be encountered in moving the large number of people who occupy modern buildings, and these difficulties should be taken into account during the development of contingency plans.

Organizations (including emergency services providers) also need to consider the potential effect on their businesses if they are unable to use their premises for 1 or 2 days, a week, or maybe never. For example, contingency plans and computerized systems need to be stored or to have a backup at least one-half mile away. Security arrangements, identification of key personnel, telephone requirements, interim office space needs, and arrangements for contractors to make repairs and replace shattered windows all should be considered ahead of time to facilitate quick response to an explosion. By educating and working with the business community before a bombing takes place, police departments can help to make the response to such an incident run more smoothly, reducing casualties and minimizing the time required to restore order.

PRACTICE, PRACTICE, PRACTICE

The need to practice planned responses to bomb incidents cannot be overemphasized. In addition to the citywide plan, each of the emergency services must have its own contingency plan, which must be practiced, coordinated, and kept up-to-date. These plans should include alternatives in the event that buildings housing the emergency services themselves (e.g., fire stations, police precincts, and hospitals) are damaged or destroyed. Just as businesses should prepare for being unable to use their premises, so should emergency response teams. Routine evaluation and revision of the city's contingency plan, as well as coordinated practice drills, should be scheduled.

CONCLUSION

All major incidents are demanding and stressful for both organizations and the individuals. This particularly applies to bombs, because they represent a deliberate effort to kill, maim, and cause the maximum damage, disruption, and cost. With appropriate planning and training, casualties can be reduced, and the main priority--restoring normality--can be achieved more efficiently and quickly.

Elements of an Explosion

Blast
Air being propelled at tremendous force and speed creates an over-pressure traveling outward in all directions away from the source for great distances.

Augmented Pressure
The pressure wave, reflected and channeled by the design of buildings and layout of streets. This causes the pressure effect to last longer and can increase structural damage.

Fragmentation
Any item that is part of or near to the bomb when it explodes becomes a projectile. The larger the explosive charge, the farther the fragments will travel. Fragments normally travel in a straight line but, like a bullet, can also be deflected.

Secondary Fragmentation
This occurs as the blast over-pressure hits and breaks structures, e.g., windows, doors, collapse of false ceilings, office equipment, etc.

Partial Vacuum
Return to normal pressure. At this stage, windows not destroyed by the initial blast may be sucked out.

Ground Shock
The transmission through the ground of the blast wave pressure. This causes problems with gas, water, electricity, sewers, telecommunications, etc., and may also cause structural damage to the foundations of buildings and subway systems. (The density and height of buildings, the width of streets, the size of the device, the time of day the device is detonated, and whether a warning has been received exacerbate the effects of the explosion.)

Local Terrorism Planning Model

For most law enforcement agency administrators in the United States, the perceived threat of a terrorist act or attack within their jurisdiction is a remote possibility. Unfortunately, one cannot predict, with any degree of confidence, when and where terrorism is likely to occur. Being prepared for any eventuality is a hallmark of good administration, but preparation should be consistent, at least to some degree, with the probability of an event and available resources. It must also be measured against the potential impact that such an event might have. A terrorist act usually has a low probability of occurrence but a high impact when it does, as we have witnessed in the World Trade Center bombing in New York City, the murder of an ad exec in Caldwell, New Jersey, the recent Oklahoma City bombing and tragedy and those acts of terrorism, violence and death perpetrated by the infamous and elusive "Unabomber". Thus, it requires some serious consideration and effective and joint planning in any law enforcement, criminal justice or public safety agency or respective emergency management program serving the security and safety needs of citizens. Jurisdiction for the investigation of domestic terrorist acts rests primarily with federal agencies, but the local law enforcement agency or the established emergency management team also has an all-important and vital role when their local setting becomes the target and the primary theater of operations. Recent history has proven that that this action is necessary. It is because of the immediate municipal, county and state role that a ready-reference for countering terrorism is readily available, specifically for all law enforcement and related emergency management, civil defense and security administrators, to provide a planning framework, identify specific needs, identify areas of threat and responsibility, and to provide a source of vital and proven-effective reference materials and information. It is imperative that a model of this type be acquired and immediately implemented by each and every law enforcement agency in America, regardless of size or location, before the next internal threat, scare or resulting tragedy. The proper and highly recommended program model on countering terrorism, for early municipal, borough, hamlet, village, county and state law enforcement agency preparation and intervention, consists of eight vital parts, focusing primarily on Planning, Operations, Tactics, External Considerations, Events, Acts, The Actors and Training. Included are vital materials, far exceeding present emergency management procedures, that can easily be effectively duplicated to assist in planning activities and to distribute in an operational setting. Some of the procedures can be used the way they are, while others should be adapted to the particular jurisdiction. The importance of preparation for a potential threat will be dictated by the respective chief executive of a city, county, state or respective jurisdiction. An alarmist approach is of little value, but to ignore or belittle the threat can prove to be disastrous. A reasoned and balanced approach, emphasizing a departmental plan, offers a sensible model, because, 'it can happen here!' Recent events and historical warnings have proven this year after year. The warning signs are all around, yet, too many, in positions of authority, often because of denial, fail to recognize them.

This vital model for law enforcement to aid in countering terrorism represents the first step for the development of a truly effective plan. Although most of the preliminary work and research has been accomplished, the rest depends on the respective chiefagency executive and the delegated professional joint planning groups. Hopefully, there will never be a need for you and your jurisdiction to use this specialized model or put the plan into effect, even in the aftermath of the World Trade Center bombing disaster and the recent bombing of the Oklahoma City Federal building, and countless other, however, should an incident occur, the vital realization that there is a working plan that may and will aid in saving the lives of those served by law enforcement, public safety, emergency management, corporate security or related community-related administrations, "is just that important!"

Contents of the model plan for countering terrorism include:

Planning: Introduction and Definition

* The Role of Federal Agencies in Combating Terrorism
* The Department of State
* The Office of the Ambassador-At-Large for Counter-Terrorism
* The Bureau of Diplomatic Security
* The U.S. Foreign Service Institute
* The Bureau of Intelligence and Research
* The Office of Foreign Building Operations
* The Office of Foreign Missions
* The Anti-Terrorism Assistance Program
* The Department of Justice (DOJ)
* The Federal Bureau of Investigation (FBI)
* The Drug Enforcement Administration (DEA)
* The Department of Defense
* Justice Department Criminal Investigation
* The Joint Chiefs of Staff
* The Central Intelligence Agency (CIA)
* The Department of The Treasury
* The U.S. Secret Service
* The Bureau of Alcohol, Tobacco and Firearms (ATF)
* The U.S. Customs Service
* The Federal Law Enforcement Training Center
* The Internal Revenue Service
* The Department of Transportation
* The Federal Aviation Administration
* The U.S. Coast Guard
* The Department of Energy
* Inter-Agency Programs

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* Developing A Plan

* Operations Plan (Example)
* Implementation Guidelines
* Operations: Operations Implementation
* Operations Orders
* Command Post
* General Tactical
* Mutual Aid Procedures
* Evacuation Procedures
* Information and Intelligence
* Legal Issues and Federal Statutes Against Terrorism
* Investigative Guidelines and Statutory Authority
* State Statutes Against Terrorism

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* Tactics: Guidelines For The Terrorist Scene

* Hostage Teams and Negotiators
* Use of Force
* Bomb Procedures
* Bomb Threats and Searching
* Emergency and Bomb Tactical Units (ERT) (SWAT)

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* Investigations

* External Considerations: Introduction
* Call Assessment
* Facility and Personnel Protection
* Police and News Media Relations Policy

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* Events: Introduction and Overview

* Events

* Philosophical Issues and Positions
* Potential Targets
* Airports
* Maritime Terrorism
* Nuclear Terrorism
* Chemical Warfare
* Biological Warfare

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* Acts: Introduction

* Hostage Situations
* Kidnappings
* Bombings
* Assassinations
* Skyjackings and Hijackings

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* The Actors: Profiles of Significant Terrorist Groups

* Training: Introduction
* Management Training
* Recruit and In-Service Training
* ERT and SWAT Units
* Combined Unit Training

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* Specialized Training
* (and) Educating The Public.

Interested law enforcement and criminal justice professionals are invited to E-Mail IASO for additional information relating to the proven-effective model plan for countering terrorism.